(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL

JULY, 1906.

ADDRESS OF PRESIDENT BALL.

MASTER MECHANICS' ASSOCIATION.

From the inception of the association, thirty-eight years ago, each successive convention has marked a period of advancement in our work. At this meeting we will have presented to us, matters of even greater importance than have been considered heretofore, and this convention, above all others, will mean more to us as representatives of that important factor in railroad transportation,—the motive power department,—than any of the conventions which have become matters of history.

The past year has been noteworthy as a record breaker in the continuation of the prosperous conditions which have prevailed during the past decade. Exceptionally favorable weather conditions, combined with large additions to equipment, which our superiors had taken the precaution to provide, enabled the railroads to meet the emergency in a creditable manner. Locomotive and car plants have been taxed to their utmost capacity to meet the requirements of the railroads, whose orders in many cases were the largest placed in railroad history.

Statistics compiled for the year 1905 show a large increase in output of new locomotives, over the year 1904, as the following data will indicate:

	1905.	1904.	Inc.
Total number of locomotives built for domestic use and for export, by locomotive builders	5,491	3,441	60%
Total number of locomotives built for domestic use by the builders, and in railroad shops	5,176	3,198	61%
Compound locomotives built for domestic use	177	132	34%
Balanced compound locomotives built for domestic use	76	41	85%
Number of electric locomotives built	140	95	47%

The tendency in locomotive building during the year has been along conservative lines—no radical changes in general design being noticeable. The 4-cylinder balanced compound has not progressed in general favor as rapidly as was anticipated; its extended use being confined largely to those roads which participated in its early introduction. In view of the economy obtained in tests at the St. Louis testing plant, it is certainly deserving of more attention.

The Mallet type of locomotive, which is specially designed to meet conditions requiring a very powerful locomotive, is another type which is not being introduced as fast as its merits will warrant.

The most noteworthy change in detail design of the locomotive, one that marks a departure from long established American practice, is the acceptance of the Walschaert valve gear. This form of valve gear lends itself admirably to the heavy locomotive, having advantages in the way of accessibility for inspection and repairs, lightness, and freedom from rapid wear.

The rapidity with which this gear has grown in favor with enginemen, as well as those who have to do with the maintenance of the engine, promises well for its future. Up to the 1st of January, 1906, there were 283 locomotives equipped with the Walschaert valve gear in this country; and as an indication of the tendency toward the general adoption of this gear, one road to-day has 225 engines equipped with it.

In boiler design, much has been done incidental to the introduction of the superheater, and more will undoubtedly follow as designers take up the problem of superheating of steam for locomotive engines. Apart from this, the most radical departures in boiler design are found in the use of a combustion chamber, in long boilers using bituminous coal, with attendant remarkable results in overcoming rapid deterioration of flue ends and leaking. It is also worthy of note, that the flexible staybolt is steadily gaining ground.

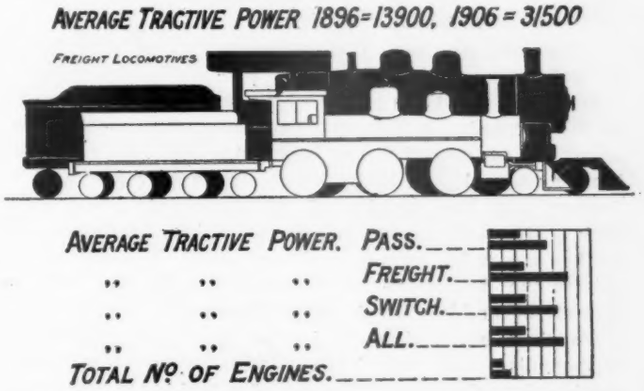
To meet the changed conditions in railway operation, as a result of the growth of the locomotive in recent years, no equipment detail furnishes a better example of progress than the advancement made in railway braking appliances. The problem of braking trains, having from four to five times their former weight, with double the number of cars, has been solved successfully, and with apparatus greatly simplified. The new engine and tender equipments represent a consolidation of all previous locomotive equipments, as far as effects are concerned, with a centralization of the functions of the different apparatus into one unit, thereby eliminating a great many parts.

Aside from what has been accomplished in the direction named, changes for economy of operation have also received attention. The introduction of the cross-compound air pump is opportune. The demands for air have increased to such an extent as to represent quite a large percentage of the boiler capacity for its production. It has been found that under normal working of a large freight locomotive, hauling a train of 65 cars, 50 of which were air-braked, at 20 miles per hour, the simple air pump requires approximately 6 per cent. of the steam generated. If a portion of this can be saved by compounding, such saving should not be overlooked. Tests which have been made, show an economy for the compound pump, of 60 per cent. over the single pump.

A list of improvements in details would not be complete without a mention of the advancement made in the art of manufacturing rolled steel wheels. Their increasing use promises well for this type of wheel.

The motive power problem, "Reduced cost per ton mile of transportation," is presented to us to-day for solution, even more forcibly than it has been presented to those who preceded us, and is deserving of more careful consideration and study than what has been accorded it heretofore. This is not merely a mechanical problem. How has the problem been met from a motive power standpoint? By providing a locomotive, the size of which has only been limited by the governing clearance dimensions. But there is something more that we can do.

It may not be out of place to refer at this time to the advancement that has been made in power capacity during the past ten years, and to reflect with pardonable pride on our having participated in the splendid movement in the upbuilding of the locomotive, which the following figures represent. The data was obtained from a road with which you are all familiar and is fairly representative of the progress which has been attained on all roads in the country. To better illustrate the following figures, diagrams have been prepared.


AVERAGE TRACTIVE POWER 1896=13900, 1906 = 31500
FREIGHT LOCOMOTIVES
AVERAGE TRACTIVE POWER. PASS.
" " " FREIGHT.
" " " SWITCH.
" " " ALL.
TOTAL Nº OF ENGINES.

In the years 1896 and 1906, the average tractive power for each class of engine, was as follows:

	1896.	1906.
For freight engines	13,900	31,500
For passenger engines	12,200	22,900
For switching engines	14,700	26,800
For all engines	13,700	28,700
Total number of engines, all classes	551	764

During the period of evolution represented by the foregoing figures, new difficulties arose; new problems required solution. In the desire for adequate boiler capacity within the limits of dimensions and weights imposed, errors were made in boiler design, in restricting the depth of the firebox, in the spacing of the flues and in the use of abnormal grate areas. With the greater use of cast steel, advantage was taken to reduce weights of details, to the extent of contributing the weight thus saved to further increase in the boiler dimensions. In some cases, such as wheel centers and frames, the lightness of the parts did not always result in failures, but their weakness contributed to the rapid wear, or failure of other dependent parts, and in other cases, failure of the parts themselves.

Experience has shown where errors of design have been made and a new basis for future calculations has been evolved, which has placed present design and construction on even a more satisfactory plane than that obtained with the lighter power. When the large locomotive went into commission the practices in vogue for the care and maintenance of the locomotive fell short of bringing results. In many cases, they brought disaster. Much of this was attributed to poor designs, when in reality the trouble lay in other directions. It was found a difficult matter to overcome flue leakage. A study of this subject by very able specialists in the motive power department has resulted in giving us definite rules regarding the care of the boilers, both on the part of the enginemen and roundhousemen, which are being extensively followed, with results as good, or better than were formerly obtained. The machinery of the locomotive, being heavier, also required special treatment at terminals, involving the adoption of the "stitch-in-time" policy, to keep the engine up to its maximum efficiency, and to avoid rapid deterioration, which was found to result from any neglect.

To provide the care necessary for the large locomotive, involved the expenditure of large sums for adequate terminals. Facilities for quick and frequent washing of boilers became imperative. Better drop pits, and more of them, were necessary. Engine houses with heating plants that would heat, and smokejacks that would ventilate, were required. The lighting of the house at night to provide for a continuous operation of the plant, on an efficient basis, was a recognized improvement. All this has been accomplished, and to-day we can be congratulated on having reached a plane of excellence, both in the design of the locomotive and in maintenance facilities, whereby the large locomotive is being handled just as expeditiously as the smaller one was, a few years ago.

Reports presented to this association on the subject of roundhouse terminals, at two former conventions, have had a marked influence in directing railroads to the appreciation of their shortcomings, in the way of adequate terminals and facilities and have played no small part in bringing about improved conditions.

How shall we meet the motive power problem in the future?

The rapid growth in power which marked the development of the locomotive in the past few years, and by which great economies of operation are being obtained, has apparently been arrested by the limitation of clearances, capacity of the firemen, and the reaching of the practicable train length limit. It would therefore appear questionable to look for further economies, as a general proposition, by continuing to enlarge the locomotive, under present conditions. The solution of the problem lies in other directions.

We shall be required to develop the mechanical stoker, compounding and superheating will be prosecuted with greater vigor than ever. The use of a feed-water heater may be resorted to, and among the smaller items, undoubtedly the compound air pump will be used, and perhaps the variable exhaust nozzle. We now have engines that will run successfully from terminal to terminal, and have reached a plane in the economical maintenance of our locomotives, whereby the use of the foregoing fuel-saving devices will make more apparent than heretofore the economies resulting therefrom. While considering the use of fuel saving devices, we must not lose sight of the economies that may be obtained through individual effort, with the facilities at hand.

This naturally leads to the subject of statistics. In following up fuel consumption on the average railroad, particularly where the pooling system is in vogue, the need for an up-to-date method of determining responsibility for the extravagant use of fuel is very apparent. Given proper weighing facilities, the problem presented is a systematic method for quickly determining at the end of each trip whether or not the coal used was in excess of the work performed, and, if so, the immediate placing of the responsibility, either with the crew or engine, as the case may warrant.

Another phase of the motive power problem, is the subject of organization. This subject has been referred to by former presidents, and while it is an old theme it presents increasingly difficult problems, if we would successfully cope with the progress of transportation. To obtain the best results in any organization, no one factor should be overtaxed. The progress of our railroads has been so great and the increase in business, while gradual, has been so persistent, that one is liable to awaken too late to the realization of having an organization inadequate to the demands placed upon it.

Consolidation of properties, and growth, have depreciated positions of the motive power department, compelling men to assume responsibilities beyond their positions. Those who have studied industrial and military organizations, find that one officer will supervise not to exceed from 26 to 30 men, while in railroad organizations, this will extend to 150 men.

In analyzing the result of consolidation, we find a master mechanic in charge of two or more divisions, where formerly only one was under his jurisdiction. After thus greatly increasing his duties, added responsibility was placed upon him by increasing the capacity of the locomotive from 50 per cent. to 100 per cent. and rapidly increasing their numbers. The same is true of roads which have not gone through the evolution of consolidation, brought about by natural growth.

We find that work is now being performed at important division enginehouses, of a character that was formerly taken care of at division shops. The work is supervised by the enginehouse foreman, acting in the capacity of the former division master mechanic, having oftentimes no special advantages at his command in the way of facilities for turning out work, with the disadvantage of an official title, the possession of which gives to the incumbent no consideration for either adequate compensation for services rendered, or proper respect for those under his jurisdiction, or consideration from those in other departments with whom he comes in contact. The modern enginehouse requires a bigger general at its head than the former small shop.

What has been said of the engine house foreman is also applicable to those subordinate in authority to him, and to those occupying similar positions of equal or greater responsibility in the shops, particularly as to compensation. Increase in wage rates granted to laboring men from time to time, very rarely apply to the foreman, with the result, in many cases, of finding the men receiving more per month than those responsible for their direction. It may be stated that overtime rates have much to do with this condition. True—but who puts in more overtime than the average subordinate official, receiving a monthly stipend? An efficient organization, under the conditions mentioned can not be built up, or maintained.

The large railroad to-day should have in its motive power department more division master mechanics, each to have allotted to him for care and maintenance, such number of locomotives as can be properly looked after, and to the extent that he may know the shortcomings and weaknesses of each individual engine and be held responsible for its performance and cost of maintenance while out of main shop. This may

require his having jurisdiction over two or more enginehouses. The main shops on each grand division to be supervised by a shop superintendent, who will be held responsible for cost per unit of shop output; each grand division to be in charge of a division superintendent of motive power; and over the entire department, an official on the staff of the president, having a thorough understanding of the department, as to its details and needs, and of sufficient knowledge and experience to present the motive power problem, and to show that it is an element in the operating problem. It is gratifying to note that one such position has recently been created on one of our more important railroads.

Another detail of organization, which is part of the motive power problem, is the establishing of systems of apprenticeship, under proper supervision, whereby the apprentice can, and will be assured a thorough, practical course of training in the shops, and for those who show the aptitude, or inclination, a special course, with the end in view of providing sufficient technical training to fit them for positions of responsibility. The apprentice of to-day is rapidly drifting out of sympathy with his employers, by reason of the indifference displayed toward him by those having him in charge. To offset this tendency he must feel that the employers have his welfare at heart and this can only be accomplished in these busy times by having an apprentice department with an official at its head, to relieve those in immediate charge. A very thorough and competent organization of this character is now in operation on the New York Central Lines.

Considerable thought and experiment has been devoted during the past year, to the development of a motor car, which could be used for branch service, corresponding to the service furnished by the interurban electric car. The most promising field of effort, has been the gasoline motor. Others have followed in the footsteps of our foreign friends and have experimented with steam, using oil for fuel. What the outcome will be, cannot be conjectured at this time. It is safe to say, however, that with the demand for such a car in sight and American ingenuity at work, a satisfactory car will be evolved in due time.

The association has before it for consideration reports of unusual interest and exceptional value.

The report of tests of locomotives at the Louisiana Purchase Exposition, terminates the work of the committee appointed in 1903, to represent this association on the Pennsylvania Railroad Company's advisory committee, and brings to your attention the conclusion of a research of unusual magnitude and value. Beginning in the spring of 1903, the Pennsylvania Railroad system designed and constructed a locomotive testing plant and equipped it with accessory apparatus of every sort. It secured the co-operation of national engineering societies in the formation of an advisory committee, which committee had an important part in the scientific phases of the work, and it made its plant accessible to other railroad companies which furnished locomotives for test. In this manner it has determined by methods carefully chosen, with the highest degree of accuracy, the performance of eight typical locomotives and has published in elaborate form, a complete description of its methods and a full record of its results. The effect of this whole process and the results developed therefrom, as factors in the upbuilding of the American locomotive of the future, are of unusual significance.

The American Railway Master Mechanics' Association may well congratulate itself, that throughout this process, it has been represented upon the Pennsylvania Company's advisory committee by three of its chosen members, who, in co-operation with other eminent engineers, have given their time and attention to the development of the various details concerned in this great work.

The report of the committee on locomotive front ends, represents the work that has been accomplished to date. The investigations thus far conducted have been thorough, and complete and have definitely settled the principles underlying the design of locomotive front ends.

Not only has the law been established connecting the size and proper proportions of the stack with the diameter of the front end thus completing the previous system of tests initiated by the AMERICAN ENGINEER, in which the proper proportions of the stack and its relation to the various positions of the nozzle was established for a 54-in. front end, but the various styles of inside stacks, false tops to the smokebox, and different arrangements of petticoats have been experimented with, resulting in definitely deciding upon the arrangement which is most satisfactory and economical in service. Sufficient data was also obtained to explain most conclusively the reasons for the large variety of results that have been obtained from time to time in practice with different arrangements of stacks and petticoat pipes. It would appear from the experiments that the work has been carried to a completion and that no further work of this nature will be required, unless it be on something totally different to the front end arrangements which have hitherto been employed.

In the successful prosecution of this work, we are indebted to the railroads for their generous contributions; to the N. Y. C. R. R., for the loan of a large locomotive, and to Dr. W. F. M. Goss, for the active part taken in the work, and it is hoped that suitable action will be taken at this convention in testimony of our indebtedness to those just mentioned.

The association has before it, in the two reports just referred to, examples of research work excellently performed, and it will do well to follow along similar lines in its future investigations. I deem it a great privilege to be your presiding officer on the occasion of the presentation of these important subjects.

The report and discussion on the subject of mechanical stokers should stimulate interest in the development of this exceedingly important detail of locomotive construction. We should know more about stokers, and the association has acted wisely in appointing a standing committee to report progress being made from year to year.

In the discussion of classification of locomotive repairs an opportunity is presented to get into the commercial questions of the department. This phase of the subject has not received the attention it deserves, and herein lies a great opportunity for motive power men.

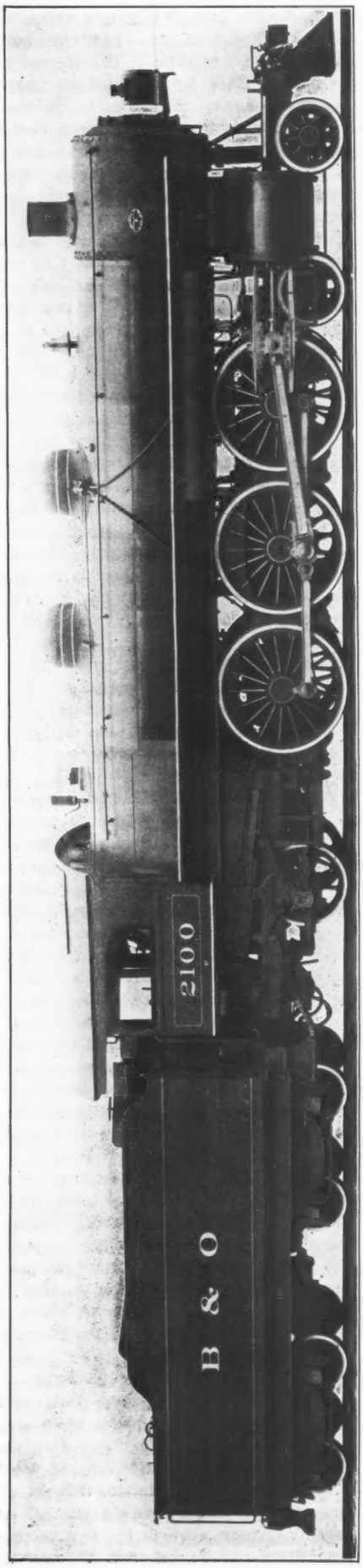
In discussing the details of enginehouse running repair work it is absolutely necessary to treat the proposition as a whole, with the view of facilitating operations at terminals to meet the needs of the operating department.

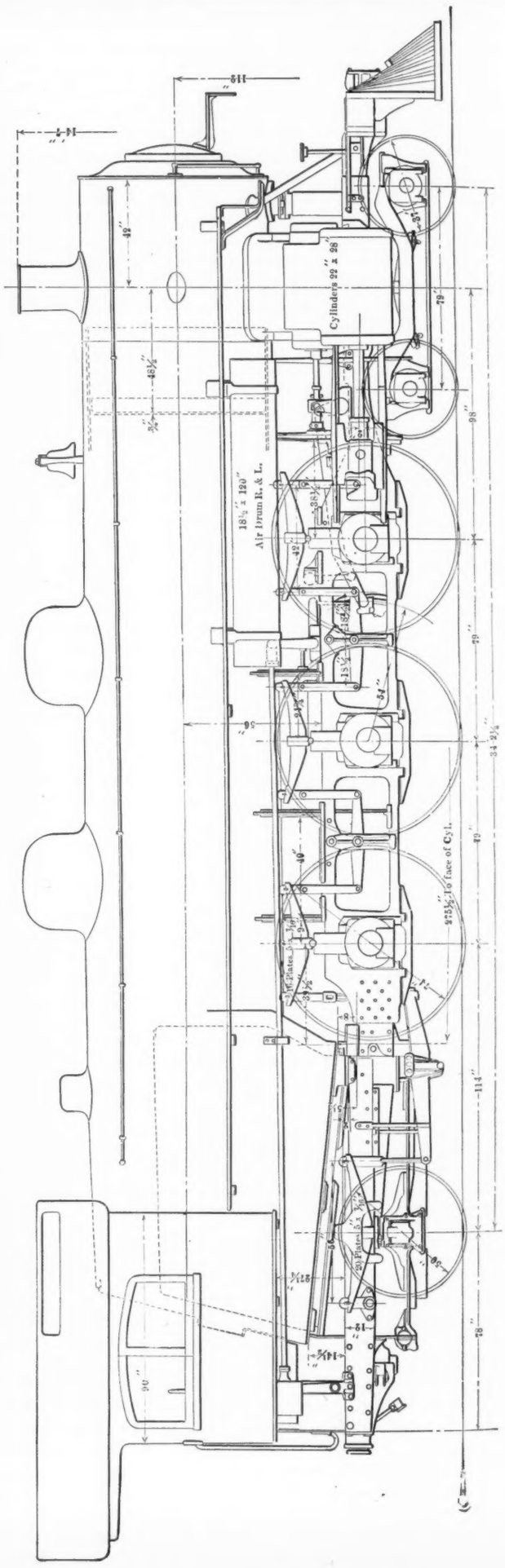
The report to be presented on the subject of "Electricity on Steam Railroads," is worthy of the most careful consideration and discussion. In view of the economy obtained in tests of the locomotive on the Pennsylvania testing plant, where it was shown that a locomotive was capable of delivering a horse power at the drawbar upon the consumption of but a trifle more than two pounds of coal per hour, the discussion of this paper should excite more than ordinary interest.

In the upbuilding process toward a higher plane of excellence of the steam locomotive, the association has for its future work the further development of the stoker, the superheater, the compound, and other details standing for lesser economies of operation, and with the end in view that their application may become general in character, the working out of a better system of statistics which will show us where we stand and put us in possession of the business facts concerning our department, making them immediately available.

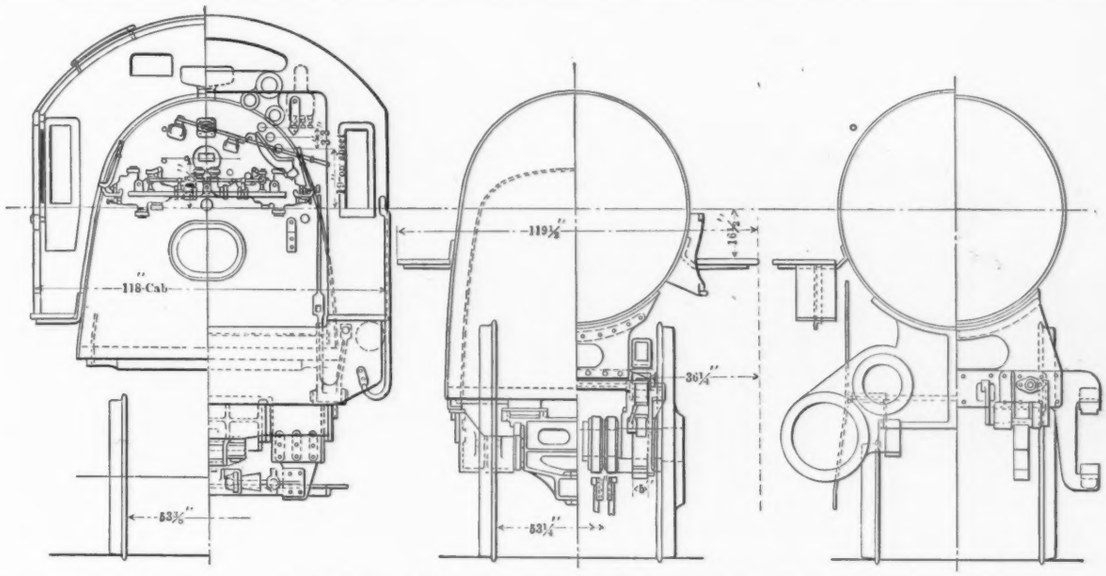
For the department as a whole the association has for future work organization, as it applies to modern shops and engine houses, up-to-date apprenticeship systems applicable to large corporations, development of motor cars for light passenger service, establishment of a bureau for scientific research work.

In connection with the latter recommendation, this association should make provision for a bureau with a salaried official at its head, to whom research work of a scientific character required of committees can be referred, through the Executive Committee. This would add value to reports and





PACIFIC TYPE PASSENGER LOCOMOTIVE—BALTIMORE & OHIO RAILROAD.



CROSS SECTIONS, PACIFIC TYPE LOCOMOTIVE—B. & O. R. R.

would relieve members of committees of a large amount of detail work to which they cannot always devote the time necessary for a thorough investigation of the subject.

The time is past when a motive power officer should be merely a good mechanic and manager of men. He must have these attributes and much more also. He is called upon to-day to be a mechanical engineer, in the design of locomotives, an executive, in the management of a great department, an organizer, in the building up of the department,—keeping it abreast of the increasing difficulties of the problems. He must be a business man, in knowing the costs of his work, and in making every dollar of the stockholders' money bring the greatest returns. He must be a diplomat in dealing with the other officials and a general in managing his subordinate officials and his men. These qualifications a man must possess in order to be an important official in any large industrial organization, but in a motive power position additional qualifications are required, which are best summed up in the statement that he must be a railroad man, ready for any and every emergency and ready to fit his work into that of others in such a way as to complete an exceedingly important corner of the organization.

In fitting our work into that of the operating department lies an opportunity, which is perhaps our greatest opportunity of the present time. Up to a certain point we can go with our own office, and up to a certain point we may introduce improvements, but beyond that point we cannot go without the heartiest co-operation of others. And it is in the direction of securing this co-operation, or in applying the operating possibilities of our positions, that our greatest future lies. That the operating officers shall consider the motive power men as their strongest supporters and most helpful allies in the difficulties of their work should be our aim, and in this direction the motive power department can undoubtedly go much farther than it has ever gone, and it is to the importance of this that I direct your attention most earnestly.

We should contribute to secure mileage of our engines always bearing in mind the fact that locomotives are not intended to make good repair records, so much as to pile up ton mileage. If the ton mileage is not always obtained the railroad machine is not working to its best advantage, and there may be good reasons for this. By helping the operating official we may find that he can help us, and in the development which tends toward the most favorable operating service lies our greatest work for the future.

Let us remember that we are not merely heads of departments. We are officials of railroads striving to increase to the utmost the net earnings, and when we have gone to the limits of our ability as mechanical men we have yet a long way to go in the direction of the operating men to improve the results. By always conducting our department so that the motive power is ready for any emergency we shall help the department, help the other officials and incidentally help ourselves. There is more before us than there is behind us in the way of improvements, and there is no work to-day lying before any class of men which is more important and more inspiring than that in which we are engaged.

BALTIMORE & OHIO RAILROAD MOTIVE POWER.

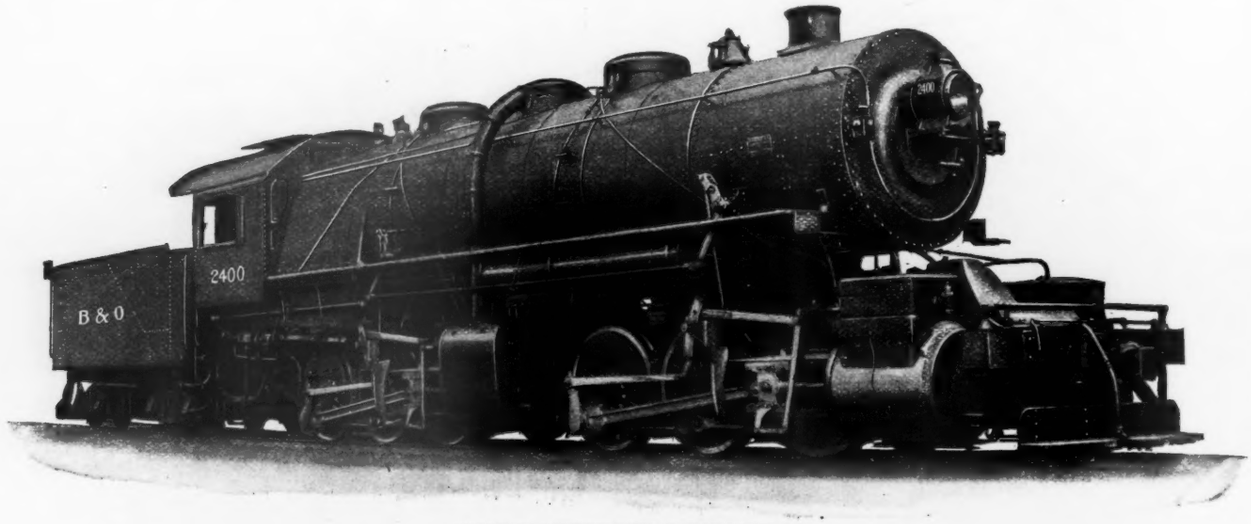
The motive power of the Baltimore & Ohio Railroad has received most substantial additions during the past three years in the shape of many new steam and electric locomotives for passenger, freight and switching service.

The most notable of these was the large Mallet compound engine, the largest locomotive in the world, which was built for the Baltimore & Ohio by the American Locomotive Company in 1904. This locomotive was thoroughly illustrated and described in the AMERICAN ENGINEER AND RAILROAD JOURNAL, 1904, pages 167, 237, 262 and 297.

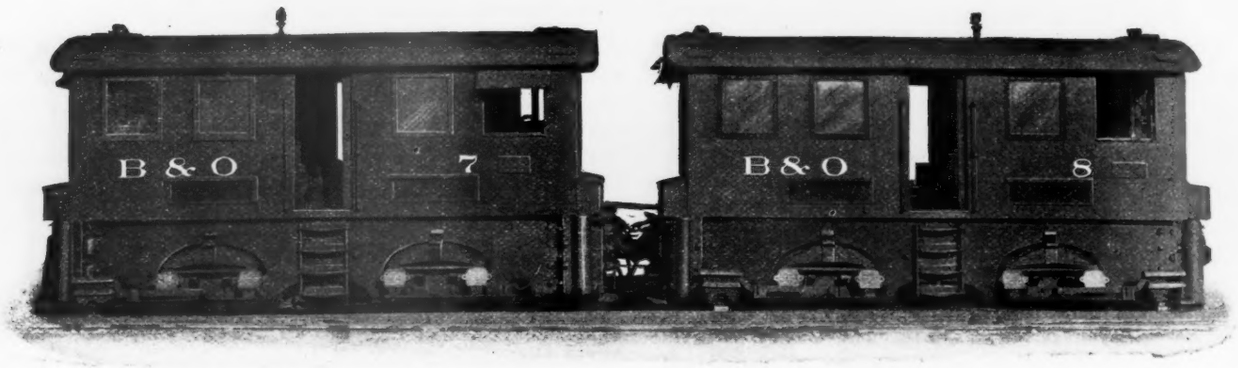
Just previous to the building of the Mallet locomotive an electric freight locomotive, consisting of two coupled units, was built by the General Electric Company for the same road. This locomotive is nearly as heavy and powerful as the above-mentioned steam engine, and was illustrated in this journal in September, 1903, page 324. A comparison of the operation and maintenance of these two locomotives was given in a paper by Mr. Muhlfeld before the New York Railroad Club in March of the present year. Extracts from this paper and Mr. Muhlfeld's remarks at the meeting will be found in this journal of March, 1906, page 101, and in this issue.

In addition to these special locomotives, which have proven to be most successful in the work for which they were designed, a large number of standard types have been purchased. These include some very heavy consolidation locomotives built by the American Locomotive Company, which were illustrated and described by Mr. Muhlfeld in the AMERICAN ENGINEER AND RAILROAD JOURNAL for January, 1906, page 29, and some heavy six-wheel switching engines built by the Baldwin Locomotive Works, the general dimensions of which are given in the table herewith.

The latest addition to the locomotive equipment consists of some very heavy and powerful Pacific type engines built by the American Locomotive Company, which are illustrated herewith. These rank with the heaviest, and are the most powerful of any of this type on our record. They have 22 by 28-in. cylinders, 74-in. wheels and 225 lbs. steam pressure, which gives them a tractive effort of over 35,000 lbs. The



MALLET ARTICULATED LOCOMOTIVE.



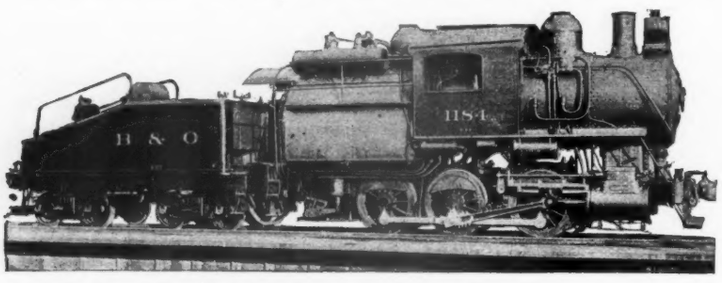
ELECTRIC LOCOMOTIVE.—TWO-SECTION EIGHT-WHEEL FREIGHT.

total weight is 229,500 lbs., of which 150,000 lbs., or 65.7 per cent., is on drivers.

The accompanying table and illustrations give a clear idea of the size and construction of these locomotives.

Mr. Muhlfeld, superintendent of motive power, states that they were particularly designed for the handling of heavy through passenger trains at the required speeds over level and mountainous, open and tunnelled railroad, of varying curvature and gradient, and that especial attention was given to the following features:

A design of motion gear that would provide for the quick



SIX-WHEEL SWITCHING LOCOMOTIVE.

starting and acceleration of trains, so that the schedule time could be maintained, or time made up without the use of helper locomotives on heavy grades and curvature, or the necessity for unusually fast running on down grades;

The greatest proportion of adhesive to total weight of engine and tender in working order;

A substantial construction of the least number of parts;

A capacity to perform continuous service without liability for failure, and economy with respect to maintenance and fuel and water consumption.

A boiler of simple design and substantial construction, with ample grate area in one plane and firebox heating surface, together with provision for a circulation of water and unrestricted passage of gases, and suitable for the consumption of a cheap grade of either gas or soft run-of-mine bituminous coals. Especial attention was given to insure dry steam at the valve chest and cylinders by the design and location of crown sheet, steam space, throttle valve opening and surge plates.

A cylinder, frame, running and motion gears, and general design that would permit of increasing the weight and tractive power of the locomotive when the boiler tubes, tires, cab, running boards, lagging, jacketting, grates, ash pan and other similar parts require replacement, due to ordinary wear and tear, and at the same time allow for a reduction of the boiler pressure should age and general depreciation of the boiler necessitate it without the renewal of any parts not entirely worn out or destroyed.

The same details of design, construction and material as specified for the consolidation locomotives were embodied in the Pacifics, so far as practicable, in order to insure the greatest interchangeability of parts between these, and the older classes of locomotives in service, as could be done without the continuance of obsolete or unsatisfactory details, which would not provide for the greatest economy in maintenance and performance.

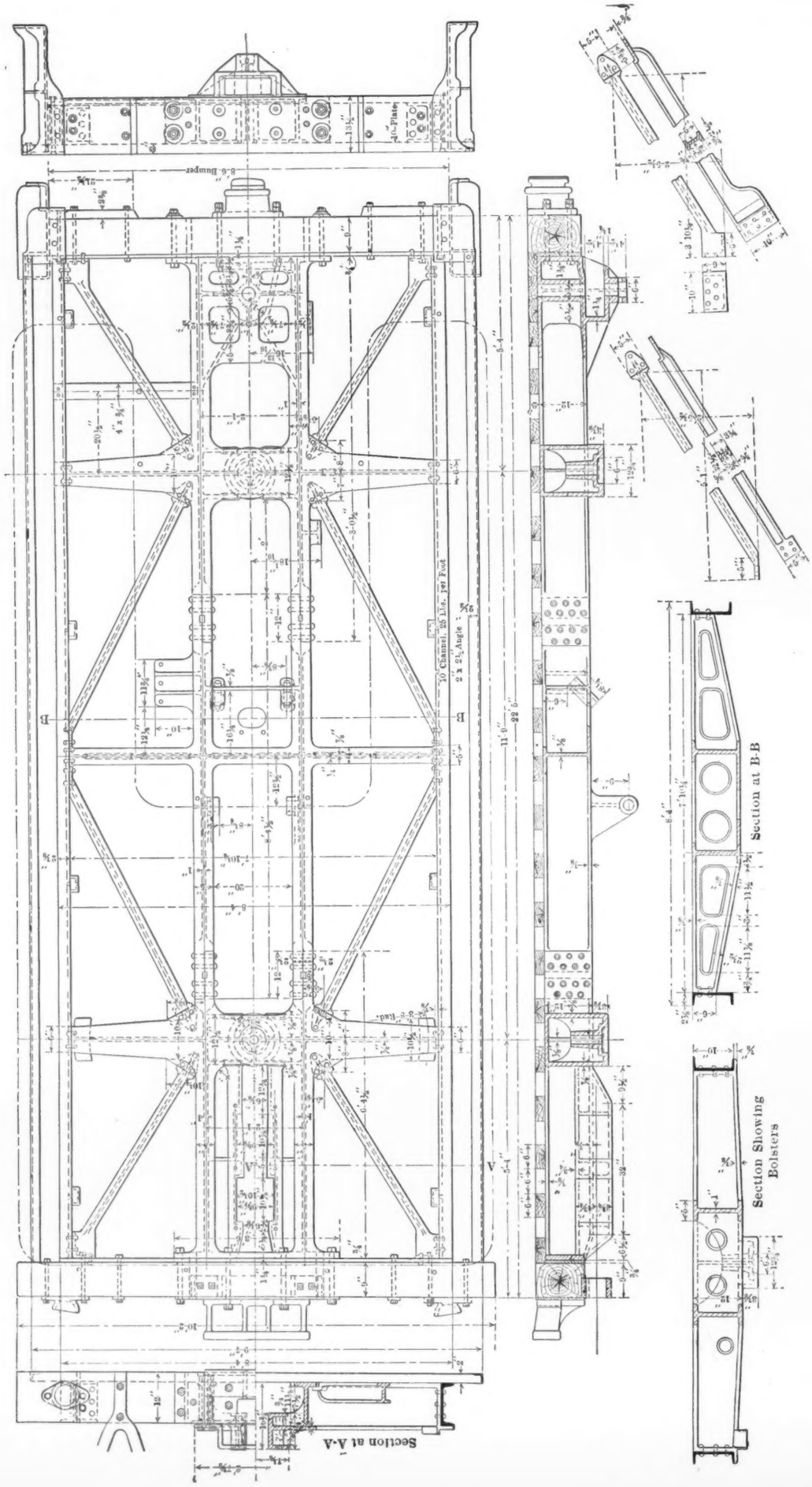
These passenger locomotives are now in regular service, and haul, without a helper, through passenger trains, consisting of 1 baggage, 1 postal, 2 vestibule coaches, 1 dining, 3 sleeping and 1 observation parlor car, or a total of 9 cars, approximating 425 tons, for a distance of 31.6 miles from Cumberland,

STEAM AND ELECTRIC LOCOMOTIVES, BALTIMORE AND OHIO RAILROAD.

Class	0-6-6-0	2-8-0	0-6-0	4-6-2	0-8-8-0	0-4-4-0
Type	Mallet Articulated	Consol.	6-Wheel	Pacific	Two-Sec. 8-Wheel	Two-unit 4-Wheel
Service	Freight	Freight.	Switching	Passenger	Freight	Passenger
Fuel	Bit. Coal	Bit. coal	Anth. Culm	Bit. coal	625D. C.	625D. C.
Tractive effort	74,600	42,168	29,740	35,020	70,000	42,000
Tractive effort starting	84,000				80,000	49,000
Weight in working order	334,500	208,500	161,080	229,500	320,000	196,000
Weight on drivers	334,500	185,900	161,080	150,500	320,000	196,000
Weight on leading truck		22,600		40,500		
Weight on trailing truck				38,500		
Weight of engine and tender in working order	479,500	352,000	246,080	376,500		
Wheel base, driving	10 ft. 0 in.	16 ft. 8 in.	11 ft. 0 in.	13 ft. 2 in.	14 ft. 6¾ in.	6 ft. 10 in.
Wheel base, total	30 ft. 8 in.	25 ft. 7 in.	11 ft. 0 in.	34 ft. 3½ in.	44 ft. 2¾ in.	23 ft. ¾ in.
Wheel base, engine and tender	64 ft. 7 in.	59 ft. 8¼ in.	40 ft. 9½ in.	65 ft. 6¾ in.		
RATIOS.						
Weight on drivers ÷ tractive effort	4	4.4	5.4	4.3	4	4
Total weight ÷ tractive effort	4	4.95	5.4	6.55	4	4
Tractive effort x diam. drivers ÷ heating surface	740	905	935	760		
Total heating surface ÷ grate area	77.5	49.5	22.4	60.5		
Firebox heating surface ÷ total heating surface	3.92	6.4	10.5	5.23		
Weight on drivers ÷ by total heating surface	59.7	66.2	98	44		
Total weight ÷ total heating surface	59.7	74.5	98	66 5		
Volume both cylinders, cu. ft	18.75	13.2	9.2	12.3		
Total heating surface ÷ vol. cylinders	298	211	179	278		
Grate area ÷ vol. cylinders	4.17	4.25	7.95	4.56		
CYLINDERS.						
Simple or Compound	Compound	Simple	Simple	Simple		
Type of compound	Mellin					
Diam. high or simple	20 in.	22 in.	19 in.	22 in.		
Diam., low	32 in.					
Stroke	32 in.	30 in.	28 in.	28 in.		
Number of Cylinders	4	2	2	2		
VALVES.						
Type of gear	Walschaert	Stephenson indirect.	Stephenson indirect.	Stephenson direct.		
Kind of valves	H.P. 10 in. piston L.P. slide-double ports.	Balanced Slide.	Balanced Slide.	Inside admission piston		
Greatest travel	6 in.	6 in.	5 7/16 in.	6 in.		
Outside lap	H.P. 1⅛ in. L.P. 1 in.	1¼ in.	¾ in.	L—L		
Inside clearance	H.P. ¼ in. L.P. ¼ in.	⅛ in.	1/32 in.	1 in.		
Lead in full gear	H.P. ⅛ in. L.P. ⅛ in.	1/16 in.	1/16 in.	1/16 in.		
No. of driving wheels	12	8	6	6	16	8
Diameter	56 in.	60 in.	52 in.	74 in.	42 in.	62 in.
Diam. of truck wheel		33 in.		37 in.		
Diam. of trailing wheels				50 in.		
BOILER.						
Style	Str. top.	Str. top.	Wooten	Str. top.		
Working pressure	235	205	180	225		
Outside diameter of first ring	84 in.	74 7/16 in.	70 in.	72 in.		
Firebox, length and width	108⅛ in.	108⅛ in.	110 in.	108⅛ in.		
Firebox plates, thickness	96¼ in.	75¼ in.	96 in.	75¼ in.		
Tubes, number	436	282	229	276		
Tubes, outside diameter	2¼ in.	2¼ in.	2¼ in.	2¼ in.		
Tubes, length	21 ft. 0 in.	15 ft. 10 in.	11 ft. 6 in.	20 ft. 0 in.		
Heating surface, firebox	220.0	179.4	172.84	179.4		
Heating surface, tubes, water sides	5380.0	2612.8	1476.67	3234.6		
Heating Surface, total	5600.0	2792.2	1649.5	3414.0		
Grate area	72.20	56.24	73.33	56.24		
Height center of boiler above rail	10 ft. 0 in.	9 ft. 10 in.	8 ft. 9 in.	9 ft. 4 in.		
Extreme height above rail	15 ft. 0½ in.	14 ft. 10 in.	14 ft. 11¼ in.	14 ft. 7 in.	15 ft. 0 in.	14 ft. 7½ in.
TENDER.						
Type	Water bottom	Water bottom	U sloping back	Water bottom.		
Coal, tons	16	15	6	15		
Water (U. S. Gals.)	7,000	7,000	4,000	7,000		
H.P. at 10 M. P. H. behind tender	2,096	1,124	686	924	2,096	1,410
Tons of loads capable of hauling at 10 M. P. H. on 1 per cent. grade	2,200	1,180	720	970	2,200	1,480

Md., to Manila, Pa., near the crest of the Allegheny Mountains, the total rise in altitude being 1,588 ft., in 63 minutes. This distance is made up of an average gradient of 4 per cent. between Cumberland and Hyndman, a distance of 13.9 miles, and of 1.4 per cent. between Hyndman and Manila, a distance of 17.6 miles, run on a 1.5 per cent. grade with 8 deg. reverse curvature between Roddy and Manila, and a 1.5 mile on a 1.93 per cent. grade. They are also hauling passenger trains consisting of 11 cars and approximating 500 tons from a dead stop for a distance of 7 miles on a 1 per cent. grade with from 1 to 8½ deg. curvature in 14½ minutes.

The table of dimensions also includes the electric passenger locomotives purchased about 10 years ago, which have a total weight of 196,000 lbs., and a tractive effort of 42,000 lbs. These have been and are in successful operation, and are of particular interest in connection with the electric passenger locomotives now being built for the New York Central and New York, New Haven & Hartford railroads.



CAST STEEL TENDER FRAME—CENTRAL RAILROAD OF NEW JERSEY.

CAST STEEL TENDER FRAME.

CENTRAL RAILROAD OF NEW JERSEY.

The Central Railroad of New Jersey has recently put into service several tender frames of the design illustrated herewith, which from the standpoint of simplicity, strength and rigidity are undoubtedly an improvement over the usual structural steel design.

This frame is made principally of cast steel and comprises, exclusive of the bumpers, floor and attachments, but 13 separate parts of which 11 are cast steel. The three largest of these castings form the main part of the frame, including the center sills, bolsters, draft casting and the cross support in the centre. The other eight cast steel parts comprise the diagonal braces the location of which is clearly shown in the illustration. The joints between the three principal castings are made just inside the bolsters at points most convenient for casting and the clearance of attachments.

CAST STEEL TENDER FRAME—THREE MAIN CASTINGS FITTED.

The "I" section has been used throughout and much care was given to eliminate any large masses of metal at any single point and except at the joints between the castings and diagonally across the junctions there is no section thicker than one inch.

The center sills are 12 ins. deep with a 1-in. web and a 5 in. flange and the side sills are 10 in. channels securely riveted to the castings at the bolsters, corners, etc. The draft attachments at either end are cast integral with the sills and made amply strong by the proper location of numerous webs and flanges. Side bearings are cast on the rear bolster only as is the practice on tender frames on this road. The drawings and photographs clearly show the details and general appearance of this interesting design. The lugs and projections noticed on the centre castings are for attaching a water scoop and the auxiliary reservoir.

Contrary to what might be expected this frame is lighter than a built up steel frame of equal or less strength, as is shown by comparing it to such a frame on the Central Railroad of New Jersey, which is 15½ ins. shorter. The weights of each complete are as follows:

Cast steel frame—11,757 lbs.

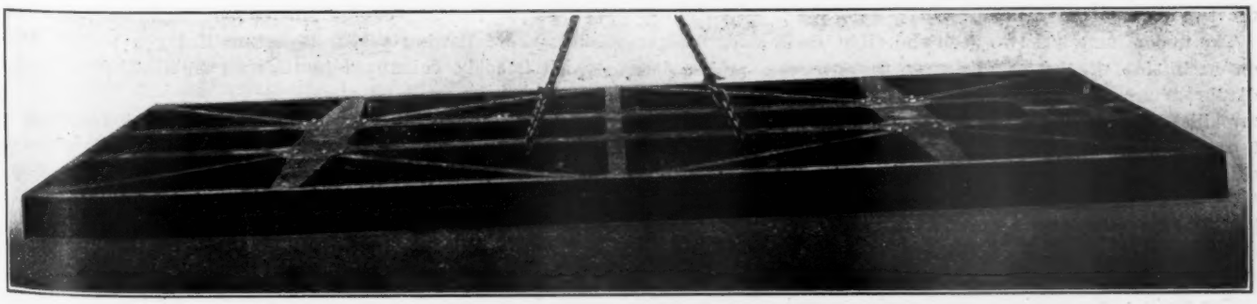
Structural steel frame—11,980 lbs.

The essential features of this design have been patented. We are indebted to Superintendent of Motive Power William McIntosh for the illustrations and information. The frame was designed in the drawing room of the Jersey Central under the direction of Mr. B. P. Flory, mechanical engineer.

One of these frames arranged with a transom draft gear was exhibited at the Atlantic City conventions by the Commonwealth Steel Company, who made the castings for all the frames.

RAILROADS AND THE TIMBER PROBLEM.—A railroad should have a man who can deal with timber in its broadest sense. I do not mean a purchasing agent, but a technical man, who should have a position equivalent to the consulting engineer, reporting to the vice-president or general manager. He should be able to deal with forest lands in their relation to railroad supplies, with timber inspection, handling, treatment, and its final disposition. He should have authority to make investigations with competent assistants so as to keep himself posted as to changes in methods, as to timber values, maintenance problems, etc., and his opinion should be that of an expert. So far as I know, only one railroad has so far created a position of manager of a tie and timber department in the sense indicated. It is particularly striking that this should be the Atchison, Topeka and Santa Fe Railroad, a road with the largest experience in timber treating of any in this country. The example which they have set should be followed by others.—*Dr. Hermann von Schrenk, American Forest Congress.*

THE MOTIVE POWER PROBLEM.—This is the locomotive problem for the immediate future—to provide more power without greatly increasing existing weights. A secondary, but scarcely less important field for effort, is the improvement of design and method of operation which will reduce road service failures. Another opportunity for the greatest abilities lies in revolutionizing methods of motive power management to bring them into parallel with those methods which have brought the greatest successes in the management of vast industrial establishments. Altogether the motive power problem presents possibilities as great as those of any field of mechanical activity, and these are worthy of the efforts of the best of men.—*Mr. G. M. Basford, at Purdue University.*



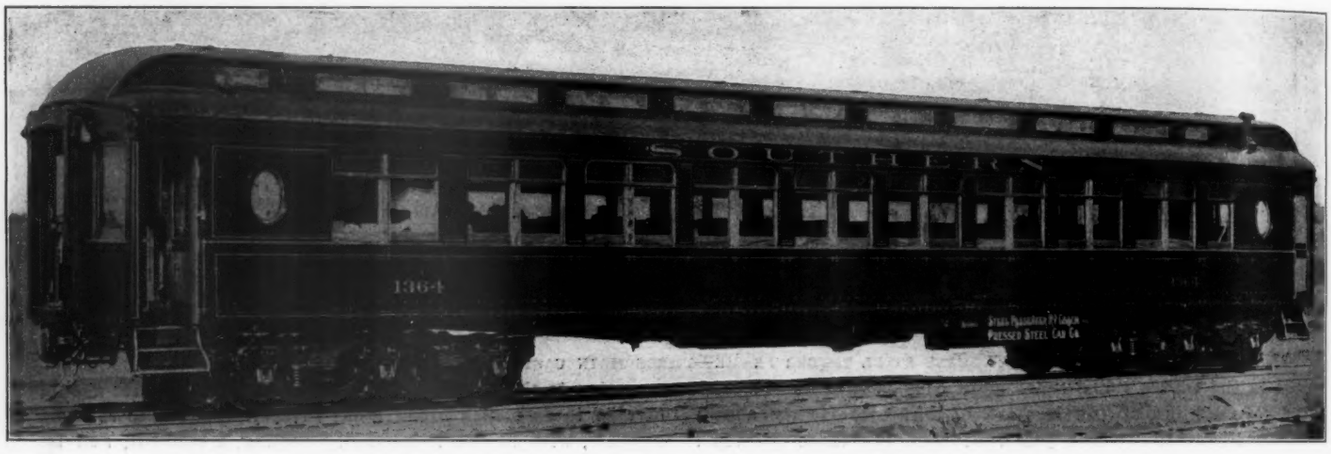
CAST STEEL TENDER FRAME COMPLETE.

COMBINATION STEEL AND WOOD PASSENGER CAR.

The Southern Railway is having three combination steel and wood passenger cars built at the works of the Pressed Steel Car Company, one of which was exhibited at the Master Mechanics' and Master Car Builders' conventions at Atlantic City. The leading dimensions of the car are as follows:

Length over platforms	74 ft.	6¼ ins.
Length over body and sills	66 "	0 "
Total inside length	65 "	3¼ "
Distance from center to center of trucks	50 "	0 "
Width over side sheets	9 "	10¼ "
Width inside between finish	8 "	10¾ "
Height from top of rail to top of body	14 "	2 "

The size of the car and the interior arrangement and equipment correspond as nearly as possible to the Railway Company's standard coach. The underframe, framing, platforms, platform sills, body carlines, and the side sheets on the outside below the windows are made of steel in the form of plates and pressed, rolled or built up parts, depending on the requirements. The interior finish, doors, windows, window sash, upper part of the floor, roof and the outside above the window sills are of wood.



COMBINATION WOOD AND STEEL PASSENGER CAR FOR THE SOUTHERN RAILWAY.

The underframe is composed of two fish-belly center sills built up of ⅜-in. plates, 22 ins. deep at the center and 13⅛ ins. over the bolster. These plates are reinforced with angle irons and cover plates, and extend the length of the car between the platform sills. The body bolsters are double, spaced to suit six-wheel trucks, and consist of 7-16-in. plates 13⅛ ins. deep near the center sills, tapering toward the sides and reinforced with T-irons and cover plates on top and bottom. The side bearings are supported on 8-in. I-beams, secured between the two parts of the bolster.

The underframe has two deep and eight shallow diaphragms on each side of the car between the bolsters. The deep diaphragms consist of ¼-in. plates, 20½ ins. deep at the center sills, and are reinforced with T-irons and cover plates on top and bottom. The shallow diaphragms consist of 7-in. channels. The side plates below the windows are 3-16 in. thick of cold-rolled steel, reinforced with angle irons at the bottom edge, and with a special shape at the top edge under the window sill. Both of these reinforcing members extend the full length of the body.

The main posts consist of two angles spaced apart, and the intermediate posts are T-irons. The main posts extend from the bottom of the side plate to the roof, but the intermediate posts extend from the roof to the window sill only, at which point they are riveted to a reinforcing plate extending between the main posts inside of the side sheets. The framing at the ends consists of angles at the corners and of three channels reinforced with plates on each side of the door. The platforms are supported on the center sills and on 6-in. channels. The platform end sills are pressed of 5-16-in. steel plate into channel shape and to suit the vestibule fixtures.

All vertical lines of rivets on the outside of the car are covered with special drawn steel moldings, which give the appearance of the broad panels used on wooden cars. Because of using the Railway Company's standard six-wheel trucks with standard height of bolsters and center plates, it was impossible to make the depth of the bolsters and center sills over the trucks sufficient to bring the center line of the draft gear above the lower edges of the center sills.

The floor is composed of ⅛-in. steel plates, upon which are laid two courses of wooden flooring, each ¼ in. thick with ⅛-in. felt paper between. The top of the floor is covered with 3-16-in. linoleum.

The design of these cars was worked up by the Pressed Steel Car Company subject to the approval of Mr. A. Stewart, mechanical superintendent, and Mr. R. L. Ettinger, consulting mechanical engineer of the Southern Railway. The use of steel adds greatly to the strength of the car, and thus to the safety of the passengers in case of accident. It is one of the first passenger coaches of this type built for use on steam roads, and while future cars will undoubtedly be changed more or less it is a decided improvement in the right direction. It is understood that the Pressed Steel Car Company is at the present time working on designs of several types of steel passenger coaches with steel trucks which will be entirely fireproof.

THIRD-RAIL CLEARANCES.

Mr. F. M. Whyte, general mechanical engineer of the New York Central Lines, on behalf of a committee which was appointed to investigate the question of third-rail clearances, at the recent meeting of the Master Car Builders' Association, made the following verbal report outlining a written report which is to be submitted in time for publication in the proceedings:

As I understand it, the object of bringing this matter to the attention of the Association is to get in the records of the Association the dimensions for third-rail clearances, not only that, but to present to the Association some peculiar conditions which might be overlooked by the members.

In the first place, the third-rail location, particular location, depends upon several things. So far as power and locomotive work is concerned, the further out the third rail the better, but for various reasons it can be located too far for successful operation. At switches and cross-overs there is necessarily a gap in the third rail; that is, there is either a "dead point" or overhead construction is provided to carry the equipment over the gap. The further the third rail is from the running rail, the longer these gaps, and at places the gaps are too long for the length of locomotive which is now used or we are preparing to use, and in some cases even longer than the ordinary suburban train would extend. So on this account it is desirable to keep the third rail reasonably close to the running rail. Also, there are a good many truss bridges

all ready on the right of way, and the gusset plates for these are so located that the third rail might interfere with them if placed beyond something like the present limits, 28 or 30 ins. The passenger station platforms also would be affected; and, of course, if the third rail is moved further away the shoes on the trucks must be carried out to meet it, and it is best that these shoes should not project any further than is really necessary. These are some of the things that need to be considered in locating the rail horizontally with respect to the running rail. Vertically, it is desirable to keep the rail as low as possible, and if it were possible the top of the third rail should be located flush with the top of the running rail. There are two kinds of third rail, one the over-running, with the shoe on top of the rail, the other the under-running, with the shoe beneath the rail, and with the over-running rail there is a pressure which carries the shoe down. As the shoe runs off the third rail, the pressure still carries the shoe somewhat lower, so that it is necessary to keep the third rail a sufficient distance above the running rail to allow for this additional depression of the shoe and still permit the shoe to cross frogs, turn-outs, switches, etc. With the under-running rail the shoe would rise up on leaving the third rail, and clear these other rails better; but there must be clearance, of course, between the top of the track rail and the inside of the third rail for the thickness of the shoe. As I recall the figure now, the difference in height is 3½ ins., and that is not great, considering allowances for the spring motion of the shoe itself. These are the conditions which locate the third rail vertically.

As to the clearance diagram of the third rail, or that part of the clearance diagram relating to the third rail, that must be considered in a different light from the remaining part of the clearance diagram. The third rail is located the same distance from the running rail on curves as on tangents. The shoes are on the trucks, and therefore do not offset with the curvature, so that in car and locomotive work we must keep far enough inside the third-rail diagram to allow for curvature. The rest of the diagram is provided for by the engineering department, that is, above the third rail. If there are obstructions at curves, they are set back far enough to allow for the offset of cars, but in third-rail work that is impossible, or considered so thus far. The distance which truss rod bearers, battery boxes and other attachments to passenger cars and freight cars should be carried in from the third-rail clearances will depend upon the wheel base of the car, or the distance between truck centers, I should say. With a 56-ft. truck center the offset on a 20-deg. curve is about 17 ins. I speak of a 20-deg. curve, because that is the sharpest curve which the New York Central expects to use in their through yard as distinguished from the suburban yard.

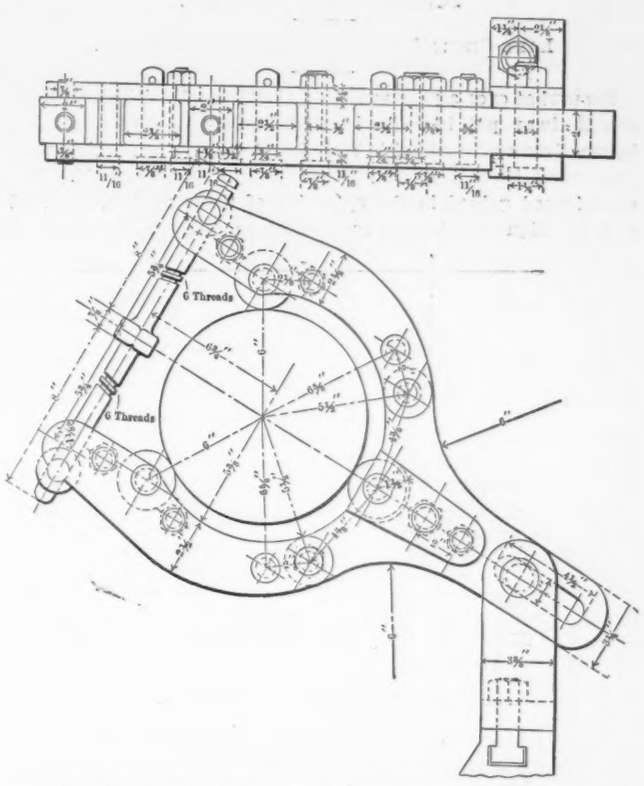
I think it would be the intention of the committee to include in the report the clearance diagrams of those roads which now have some third rail located, and call attention to those particular features which should be observed by those who care to construct their equipment so that it will clear the third rail.

ADVICE TO YOUNG MEN ENTERING THE MOTIVE POWER DEPARTMENT.—Without in any way reflecting upon the opportunities offered in the line of mechanical engineering work, it should be said that experience either in the shops or in the roundhouse is important for a young man who is to succeed. It seems desirable to positively recommend young men to delay entering the engineering work until they have had experience in one or both of the other branches. If they are by temperament and ability qualified for either shop or road administration, they will learn this fact most easily and quickly in connection with the actual work, and if they are better fitted for engineering problems, they will be better able to handle them later on because of the road or shop experience. It seems, in general, desirable for most young men to avoid the drafting room immediately on completion of their college work, and it is believed that in this most railroad officials will agree.—*Mr. G. M. Basford, at Purdue University.*

ROLLER FOR DRIVING JOURNALS.

It has been the custom in many railroad shops to roll the journals of locomotive driving axles, after they have been machined, for the purpose of giving as smooth a surface as possible and reducing the tendency to heat at the start. The tool for doing this, in many cases, consists simply of a hardened steel roller mounted in a yoke, which is set into the tool post of the axle lathe, and the pressure for rolling is obtained by tightening up on the cross feed of the carriage. Inasmuch as satisfactory results require sufficient pressure to crush the inequalities left by the turning tool on the journal, this single roller method places a very heavy strain on the lathe carriage, and at the best requires a considerable length of time to obtain a smooth surface.

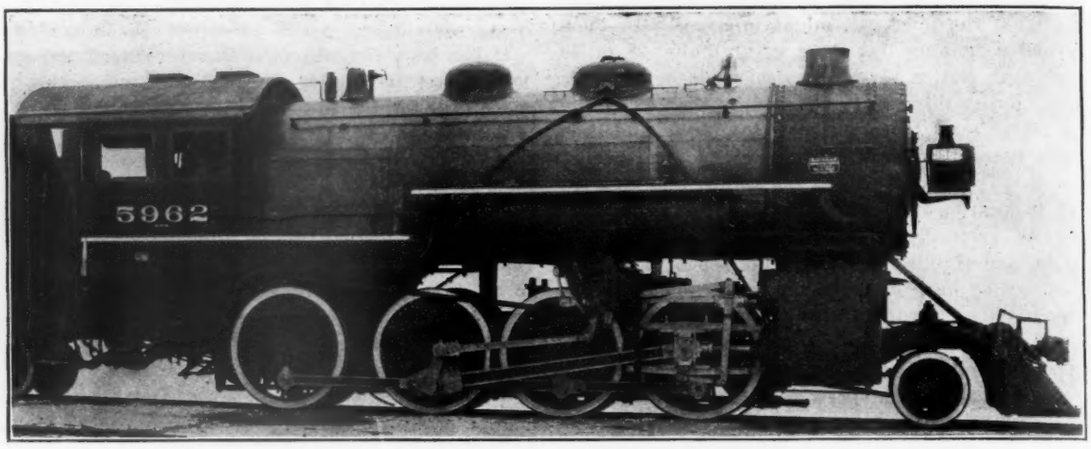
We illustrate herewith a device which has been designed and is in use at the Columbus shops of the Pennsylvania Lines west of Pittsburgh, which not only eliminates the objection of the stresses on the tool post, but also permits a much heavier pressure of the rollers against the journal, thus giving a better result in shorter time. This tool as can be



seen in the illustration, employs three rollers set at equal distances around the journal, two of them being mounted upon swinging arms, which are hinged at their inner ends to a yoke containing the third roller and reaching to a connection on the lathe carriage. The outer ends of these arms are drawn together by a double-threaded bolt. It is easily recognized that when this tool is in place (which operation is easily performed, since one end of the tightening screw block fits into a notch in the swinging arm on that end and can be released and swung downward, to allow the whole yoke to be placed around the axle) there is only a downward strain, due to the resistance of the rollers in revolving, placed upon the lathe carriage.

The rollers, which are of hardened steel, have a diameter of 2½ ins. and a length of 2 ins., and run between a framework consisting of ¾-in. iron, the two sides being spaced and connected by bolts and thimbles at the proper points.

"And it is the minute of talk after the hour of thought, the ounce of effort after the ton of preparation, that steers a business project into the harbor of success."

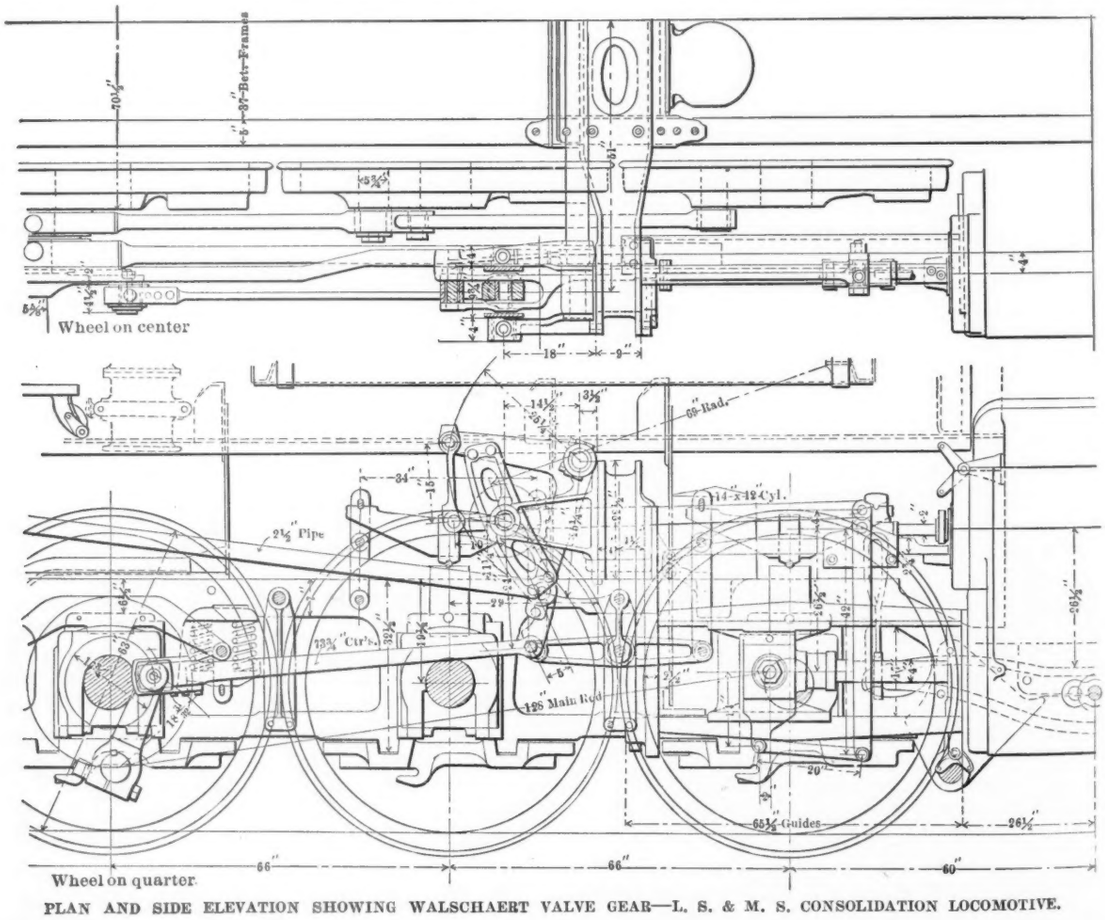


SIMPLE CONSOLIDATION LOCOMOTIVE WITH WALSCHAERT VALVE GEAR—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

SIMPLE CONSOLIDATION LOCOMOTIVE WITH WALSCHAERT VALVE GEAR.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

Somewhat over a year ago the Lake Shore & Michigan Southern Railway put into service some very heavy consolidation locomotives equipped with Walschaert valve gear, which were illustrated in this journal in February, 1905, page 46. The experienced gained in the operation of those engines has lead to a redesign of this part for use on an order of very similar engines which have recently been put into service and are illustrated herewith.



PLAN AND SIDE ELEVATION SHOWING WALSCHAERT VALVE GEAR—L. S. & M. S. CONSOLIDATION LOCOMOTIVE.

The illustrations show this new design so clearly that it needs but little explanation, and by reference to them it will be seen that the support for the small crosshead connecting to the valve stem has been placed on an entirely separate guide, which is fastened to the back valve chamber head and through a link to the guide yoke instead of having it supported directly from the main guide, as in the previous design. The bearings for the reverse shaft and the link have been placed near together in the same casting and the radius arm of the valve gear is operated through a hanger from the arm of the reverse shaft instead of a sliding joint, as was used before when the reverse shaft was suported in a bearing on the frame between the second and third pair of drivers. The link itself has been made somewhat larger and more bearing surface given to the block. The casting forming these bearings is fastened to a massive but not excessively heavy steel casting extending across the frame. The construction of this casting and its dimensions are clearly shown in the illustration. To this is also fastened the yoke supporting the main guides. Another change is also noticed in that the arm from the reverse shaft, to which is connected the reach rod, extends downward instead of upward. This necessitates the reach rod being placed outside the driving wheels and on an incline from the

reverse lever. It is supported and steadied by a guide at the throat sheet. A change has also been made in the return crank connection at the main pin for the purpose of permitting it to be more quickly and easily removed, as it has to be whenever the rods have to be taken down. While the construction at the guide yoke appears to be very heavy and cumbersome, a careful examination of the drawings will show that it is really more simple than the previous design, which was a more open one.

The application of the Walschaert valve gear to this new order of engines after over a year's trial in service can be accepted as evidence that it has proved in general to be satisfactory and that the disadvantages which have been claimed to be inherent with the design have not been found after careful trial to be great enough to overcome its many evident advantages.

For other features of these very large engines reference can be made to the descriptions of the previous similar locomotives built for the Lake Shore and the New York Central in the AMERICAN ENGINEER AND RAILROAD JOURNAL, February, 1905, page 46, and January, 1904, page 16. The general dimensions, weights and ratios are as follows:

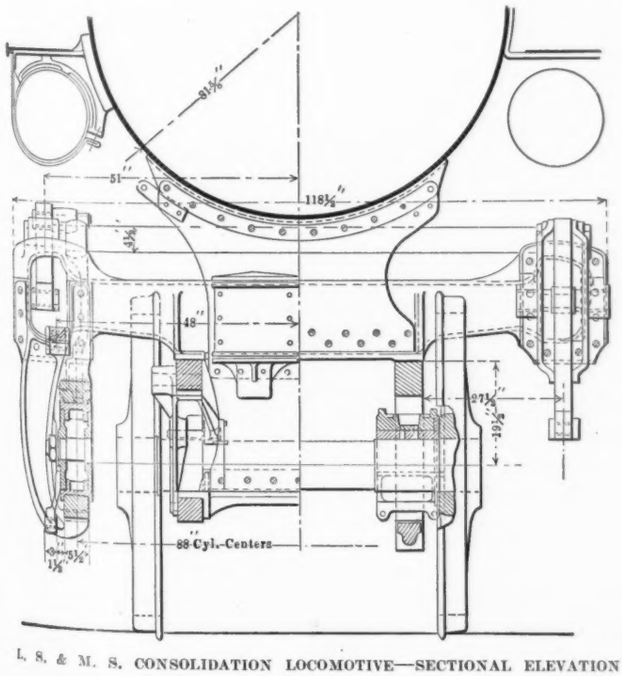
SIMPLE CONSOLIDATION LOCOMOTIVE, LAKE SHORE AND MICHIGAN SOUTHERN.

GENERAL DATA.

Gauge	4 ft. 8½ ins.
Service	Freight
Fuel	Bit. coal.
Tractive power	45,677 lbs.
Weight in working order	232,500 lbs.
Weight on drivers	207,000 lbs.
Weight on leading truck	25,500 lbs.
Weight of engine and tender in working order	382,100 lbs.
Wheel base, driving	17 ft. 6 in.
Wheel base, total	26 ft. 3 ins.
Wheel base, engine and tender	60 ft. 9½ ins.

RATIOS.

Weight on drivers ÷ tractive effort	4.5
Total weight ÷ tractive effort	5.1
Tractive effort x diam. drivers ÷ heating surface	775
Total heating surface ÷ grate area	65.8



L. S. & M. S. CONSOLIDATION LOCOMOTIVE—SECTIONAL ELEVATION NEAR GUIDE YOKE.

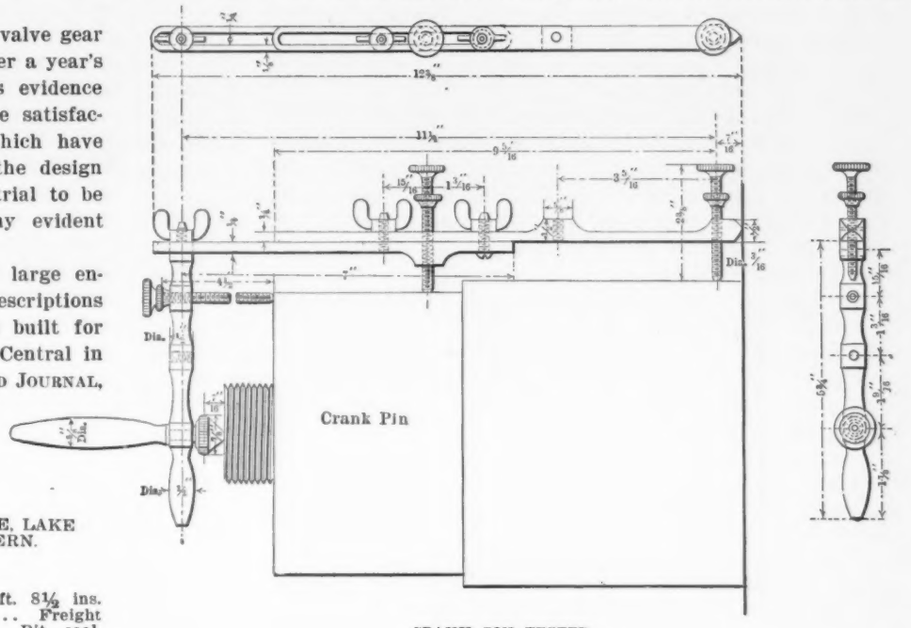
Firebox heating surface ÷ tube heating surface	6.1%
Weight on drivers ÷ total heating surface	56
Total weight ÷ total heating surface	62.8
Volume both cylinders	15.4 cu. ft.
Total heating surface ÷ vol. cylinders	240
Grate area ÷ vol. cylinders	3.66

CYLINDERS.

Kind	Simple.
Diameter and stroke	23 x 32 ins.

VALVES.

Kind	Piston
Diameter	14 ins.
Greatest travel	5½ ins.
Outside lap	1⅛ in.
Inside clearance	0 in.
Lead in full gear	17/64 in.



CRANK PIN TESTER.

WHEELS.

Driving, diameter over tires	63 ins.
Driving, thickness of tires	3½ ins.
Driving journals, main, diameter and length	10 x 12 ins.
Driving journals, others, diameter and length	9½ x 12 ins.
Engine truck wheels, diameter	33 ins.
Engine truck, journals	6 x 12 ins.

BOILER.

Style	Radial Stayed
Working pressure	200 lbs.
Outside diameter of first ring	81⅝ ins.
Firebox, length and width	108½ x 75¼ ins.
Firebox plates, thickness	⅜ and ½ in.
Firebox, water space	4½ ins.
Tubes, number and outside diameter	446-2 in.
Tubes, length	15 ft. ¼ in.
Heating surface, tubes	3492.18 sq. ft.
Heating surface, firebox	185.64 sq. ft.
Heating surface, arch tubes	27.41 sq. ft.
Heating surface total	3705.23 sq. ft.
Grate area	56.5 sq. ft.
Smokestack, diameter	20 ins.
Smokestack, height above rail	14 ft. 9½ ins.

TENDER.

Tank	Water bottom
Frame	13 in. channel
Wheels, diameter	33 ins.
Water capacity	7,500 gals.
Coal capacity	12 tons.

CRANK PIN TESTER.

A simple device for testing crank pins to see whether they are bent or worn out of round is shown in the accompanying illustration. The device is applied to the crank pin, as shown, and by simply revolving it about the pin it may readily be seen whether it is bent or worn out or true. We are indebted to Mr. William Hall, foreman of the Chicago & Northwestern shops at Escanaba, Mich., for the drawing and information.

Roundhouse doors should be made of non-corrosive material; they should be easily operated, fit snugly, be easily repaired and maintained, and should not be exposed to damage by wind, directly or indirectly, and should admit of the use of small doors. The particular kind of door that will suit a given case can be determined only by giving proper value to the different factors enumerated above.—*Committee report, American Railway Engineering and Maintenance of Way Association.*

STEAM VS. ELECTRIC LOCOMOTIVES.

In presenting his paper on "Large Steam and Electric Locomotives," extracts of which were given in our March issue, Mr. Muhlfeld gave the following general conclusions drawn from the experience detailed in the paper:

At this period, when changes in alignment and gradient, and reconstruction of old as well as the construction of new steam railroad lines, are being considered, there is every opportunity for motive power engineers to demonstrate the advantages of electric over steam traction.

Some of the mountainous steam railroads present many attractions in the way of permanent and concentrated supplies of cheap coal, gas, oil or water for power, and water for condensing and cooling purposes, which in combination with suitable means for generating, conveying and utilizing electric current for locomotive traction power, might enable a profitable continuance of lines which are now being abandoned, or which, under the present operating conditions, must sooner or later be replaced at a very great cost.

However, before electricity can supersede steam for tonnage service, it must be demonstrated practically from actual installation and operation, and not theoretically, that the results which electrical engineers are predicting will be forthcoming, as railroads are not generally making heavy expenditures to increase the business and revenue and reduce operating expenses unless they have reasonable assurance of the net results.

It has been said that for the handling of heavy tonnage electric locomotives have extreme advantages; especially on heavy grades, in regard to speed; this on account of the steam locomotive not having the same endurance due to a limited supply of steam.

Up to the present time, from actual performance, it has not been found that electric locomotives having almost equivalent tractive power, when handling heavy tonnage on severe grades and curvature, can operate at greater speed than steam locomotives.

Of six geared and gearless electric locomotives now in service or under construction all are different in design, system or method of controlling, and there is every indication that none have yet practically demonstrated that they can meet the requirements for efficient and economical operation and maintenance.

Should it be necessary, from an electrical standpoint, to continue the use of gearing between the motors and driver wheels, as well as the large number of small diameter driver wheels, for heavy tonnage electric locomotives, to obtain the requisite tractive power, it would be interesting to know how the predicted largely increased speed, as compared with steam locomotives, is to be obtained with a reasonable efficiency and maintenance cost.

The arrangement of the propelling gear on the electric locomotives recently purchased by the Valtellina Line in Italy, is one that appeals to motive power people who have experienced difficulty with other types of electric locomotives now in service.

The working capacity of an electric locomotive having a total weight of 160 tons, with 42-in. diameter driver wheels, at a speed of 10 miles per hour on 1 per cent. grade, is about 1,500 tons in the train, excluding the locomotive. The working capacity of a steam locomotive having a weight of 167 tons for the engine and an average weight of 58 tons for the tender, with 57-in. diameter driver wheels, at a speed of 10 miles per hour, on 1 per cent. grade, is about 2,200 tons in the train, excluding the weight of the engine and tender.

In no instance when operating a steam locomotive of the above capacity under the most severe conditions has it been found that the boiler could not furnish all the steam required to develop the maximum tractive power of the engine.

Comparing the horse power developed, it has been found that the first cost, cost for operation and maintenance, number of and weight on driver wheels, and number of large bearings requiring lubrication, has, for the electric locomotive, been in excess of that of the steam locomotive, and there has been no benefit with respect to increased average sped on 1 per cent. grade.

A steam locomotive in one section can be designed and placed under the control of one engineer and one fireman, which will economically develop as much tractive power as may be necessary to haul the greatest amount of tonnage that can be concentrated in one train of suitable size for safe and quick handling over a division.

The advantage of the electric locomotive for the handling of heavy tonnage would be in the increasing of the capacity of the line, and it might be that the increased business handled would justify an increased cost for installation and operation of electric locomotives as compared with steam locomotives.

When compared with ordinary modern steam locomotives the advantage that the electric locomotives have are on account of no tender for coal and water, which reduces the average dead weight about 60 tons per train, which is equivalent to one car and about 40 tons paying load per train, providing the same drawbar pull can be obtained per equivalent horse power and factor of adhesion, when compared with steam locomotives. Electric locomotives will give the advantage of a high average speed obtained for the same weight on driver wheels, while the more rapid acceleration and a lower maximum speed results in less total power required to drive the train and a lower braking pressure for stopping.

The life of the steam locomotive could be maintained indefinitely by the same process as will be required to keep electric locomotives in serviceable condition, but it has been found during the past that it is more profitable to dismantle obsolete equipment and replace it by entirely new equipment than to continue the old stock in service. This will, no doubt, apply to electric locomotives when they may have reached the same average age that now results in the dismantling of steam locomotives.

From present indications, any benefit from the increased life of the electric locomotive, as compared with the steam locomotive, would be overbalanced by the cost due to continual renewals and repairs on account of ordinary wear and tear.

The cost for the first installation of power plants for generating current is too high. Under the average conditions the actual cost for the complete installation will range from $100 to $150 per horse power developed, which is from seven to ten times as much as the cost per horse power developed in the ordinary types of modern steam locomotives at a speed of 10 miles per hour.

The present types of stationary boilers are too costly and require too much floor space per horse power developed. The merits of good superheaters, economizers, feed water heaters and draft appliances should be carefully investigated for the purpose of increasing the efficiency and economy of steam boilers, which should be designed to produce more horse power per cubic foot of space occupied.

The cost for coal, ash and water supply, storage and distributing appliances as well as the expense for generators, high tension lines, transformers, exciters, converter and feeder switchboards and appliances for the distributing systems, all contribute largely to the high initial cost for power plant installations.

The size of the current generating device should not be enlarged to such an extent as will necessitate expensive foundation and building construction, overhead cranes and runways and concentrate too much power in one unit. A combination of reciprocating, turbine and internal combustion generator sets should be given consideration for the purpose of efficiency, reliability and economy.

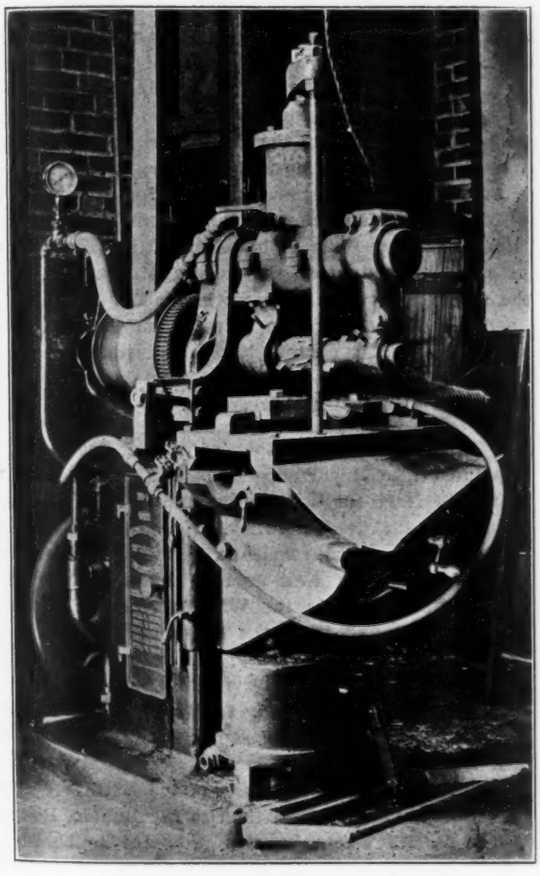
There is no doubt but that steam locomotive boilers and engines are decidedly more extravagant in fuel and water consumption than the modern power plants which are equipped with all of the refinements. At the same time there is a certain advantage and economy in the operation of a locomotive which in itself produces the power that moves it as compared with one that is dependent upon an outside source for its pro-

pulsion, and which results in transmission and conversion losses of the current before it is applied at the motors.

To electrical engineers the report and the remarks will appear to be most unfavorable for the electric locomotive operation. This, however, should not interfere with the development of an electric locomotive and power system which will give more efficient and economical results than what may have been up to the present time, or can be, obtained from steam locomotives.

What the stockholders and heads of railroads generally desire is to originate and move the greatest amount of business possible with the least cost to Capital and Operating Accounts.

The motive power engineers must co-operate in working up designs of electric locomotives. Should difficulty be experienced on account of armature burning out, the electrical engineer should not insist on the weight on driver wheels being



MACHINE FOR MILLING CAR BRASSES.

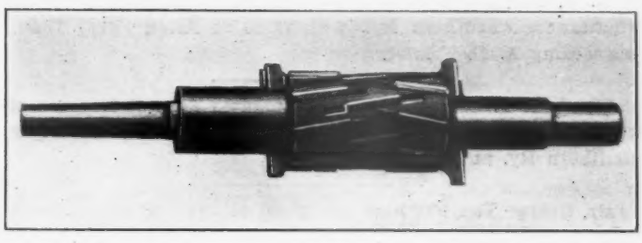
reduced to remedy the trouble; and at the same time the mechanical engineer should not require the use of pilot wheels and add unnecessary and ineffective parts and weight, if locomotives can be made to operate safely and efficiently without them.

The locomotive problem must be attacked from a transportation and motive power, and not from an electrical and mechanical engineer's viewpoint. There are sufficient locomotives of all kinds now under construction and in service on American railroads to give correct data as to what can be accomplished under varying conditions by either the electric or steam method of developing tractive power, and if unwhitewashed reports of their performance can be obtained it will be of invaluable assistance to electrical and mechanical engineers generally in meeting the present and future motive power requirements.

AUTOMOBILE EFFICIENCY TEST.—A four-cylinder air-cooled automobile carrying two passengers, ran 95 miles by using two gallons of gasolene during a test conducted by the Automobile Club of America. A gasolene-engine-propelled tricycle ran nearly 200 miles on one gallon of gasolene during the same test.

MILLING CAR BRASSES.

At the Collinwood shops of the Lake Shore & Michigan Southern Railway a No. 4 Cincinnati milling machine has been redesigned and is used entirely for the milling of car brasses. An output of four brasses per minute has been obtained from this machine and operated by an ordinary laborer, and, including the time for changing and sharpening the cutters, the machine gives an average output of 150 brasses per hour. It is entirely automatic; all that the operator has to do is to place the brass on the table, press the treadle down and release it when the brass is completed. In adapting the machine for this class of work the vertical feed screw for the table was removed and replaced by an air cylinder and piston. The height to which the table travels is regulated by means of an adjusting wedge, as shown. An automatic chuck is attached to the table, which is operated by an air cylinder; when the brass is placed on the table and the lever or treadle is operated, air is first admitted to the chuck cylinder and the brass is securely gripped. A further movement admits air below the piston of the table cylinder, raising the table and bringing the brass in contact with the milling cutter. When the table has reached the wedge the operator releases the pressure on the treadle, the table returns to its proper position, the chuck releases, and as the brass is removed a stream



INSERTED TOOTH CUTTER FOR MILLING CAR BRASSES.

of air through the hose clears the chips from the table. When large size milling cutters are used, or if the cutters are slightly dulled, the auxiliary cylinder shown above the machine is also used. It prevents excessive stresses coming on the arbor and arbor support.

The arbor of the inserted tooth cutter is made from one piece of machine steel. The tapered shank fits in the socket of the milling machine spindle. The outer end of the arbor is supported by the bracket. The carbon steel cutters are driven into milled slots. The end cutters for forming the fillet are secured by tapered keys. We are indebted for information to Mr. M. D. Franey, superintendent of the shops.

THE LARGEST STEAMERS IN THE WORLD.—A clipping, which purports to give a list of the ten largest steamers in the world, has been going the rounds of the marine press. The list is as follows:

Mauritania (Cunard), quadruple screw, turbine machinery	33,200
Lusitania (Cunard), quadruple screw, turbine machinery	33,200
Kaiserin Auguste Victoria (Hamburg-American), twin screw	25,000
Adriatic (White Star), twin screw	25,000
Baltic (White Star), twin screw	23,876
Amerika (Hamburg-American), twin screw	22,250
Cedric (White Star), twin screw	21,035
Celtic (White Star), twin screw	20,904
Caronia (Cunard), twin screw	19,594
Carmania (Cunard), triple screw, turbine machinery	19,524

This list, which we understand originated in the office of one of our American contemporaries, is incomplete in that it failed to mention the two largest ships built in the United States, which are, in cargo carrying capacity, the largest ships afloat. Their gross tonnage is greater than that of two of the Cunarders above mentioned, though less than the other ships in the list. These vessels are, of course, the *Dakota* and *Minnesota* of the Great Northern Steamship Company, and of 20,714 and 20,718 gross tons respectively. These are twin screw ships, built by the Eastern Shipbuilding Company at New London, Conn.—*International Marine Engineering.*

PERSONALS.

Mr. C. B. Cramer has resigned as master mechanic of the Southern at Sheffield, Ala.

Mr. C. I. Walker has resigned as master car builder of the National Ry. of Mexico, with office at Laredo, Tex.

Mr. W. O. Moody has been appointed Mechanical engineer of the Illinois Central R. R., with headquarters at Chicago.

Mr. A. F. Herbert, for many years general foreman of the Lake Erie & Western R. R. shops in Lima, Ohio, has resigned.

Mr. J. Stonehouse has been appointed general foreman of the Chicago & Northwestern at Huron, S. D., succeeding Mr. A. Adams, resigned.

A memorial tablet in memory of the late Edward Graftstrom, a hero of the flood at Topeka, Kan., in 1903, has been presented to the state.

Mr. R. D. Gibbons has been appointed master mechanic of the Monterey division of the Mexican Central R. R., to succeed George W. Cooper, resigned.

H. S. Lloyd has been appointed Master Mechanic of the Chattanooga Southern Ry., with office at Alton Park, Tenn., succeeding A. D. Folmer.

Mr. John T. Carroll has been appointed general foreman of the locomotive department of the Lake Shore & Michigan Southern Ry. at Elkhart, Ind.,

Mr. George Tier has been appointed foreman of the Chicago, Rock Island & Pacific Ry. at McFarland, Kan., vice Mr. R. A. Huey, assigned to other duties.

Mr. Henry J. Kutscher, who has been foreman of the Wabash shops at Springfield, Ill., for twenty-six years, has resigned, to take effect on June 1.

Mr. L. C. Rost has been appointed master mechanic of the Des Moines, Iowa Falls & Northern Ry. at Iowa Falls, Ia., vice Mr. T. D. McDonald, deceased.

Mr. S. T. Darsey has been appointed to the position of car foreman made vacant by the resignation of T. W. Sloan on the New Orleans & Northwestern Ry.

Mr. F. K. Tutt has been appointed acting master mechanic of the Missouri Pacific and Iron Mountain systems at Van Buren, Ark., vice H. K. Mudd, resigned.

Mr. W. F. Moran has been appointed master mechanic of the Southern Ry. at Sheffield, Ala., succeeding Mr. C. B. Cramer, resigned; effective on June 20.

Mr. S. E. Kildoyle has been appointed master mechanic of the Mexico division of the Mexican Central, with office at Mexico City, Mex., succeeding Mr. L. Strom, resigned.

Mr. F. Newton has been appointed master mechanic of the Sterling division, Chicago, Burlington & Quincy lines west of the Missouri river, with headquarters at Sterling, Colo.

Mr. W. H. Barrows, who has been district foreman for the Kansas City Southern Ry. at Mena, since last October, has been promoted to the position of master mechanic for the same line at Shreveport.

Mr. Michael J. Drury, master mechanic on the Albuquerque division, has been appointed master mechanic of the New Mexico and Rio Grande divisions of the Atchison, Topeka & Santa Fe Ry., with headquarters at Raton, New Mexico. He takes the place of S. W. Millinix, who resigned recently to take the position of master mechanic on the Missouri division of the Chicago, Rock Island & Pacific, with headquarters at Horton, Kans.

Mr. M. S. Tracy, assistant master mechanic of the Pennsylvania Company at Allegheny, Pa., has been transferred to Fort Wayne, Ind., in a similar capacity, succeeding Mr. L. M. Johnson, who has been transferred to Allegheny in place of Mr. Tracy.

Mr. H. M. Large, heretofore assistant master mechanic of the Erie and Ashtabula divisions of the Pennsylvania Lines, has been appointed master car builder of the Southern division of the Grand Rapids & Indiana Ry., with office at Grand Rapids, Mich.

Mr. Charles C. Newton, president and treasurer of the Newton Machine Tool Works, Inc., Philadelphia, died at Bremen, Germany, on June 13th. He was born February 9th, 1846, at Cambridge, N. Y., and at the age of nineteen he indentured himself as an apprentice to the Brooks Locomotive Works at Dunkirk, N. Y., spending most of his time in the tool room, where the foundation of his successful after career was laid. In 1880 he laid the foundation for the present Newton Machine Tool Works, Inc., at Philadelphia, in a little shop with only himself and an assistant as the working force. Mr. Newton was the sole proprietor of the works until July 14th, 1897, when articles of incorporation were taken out, not with a view of increasing the capital, but as a business move, and the firm became the Newton Machine Tool Works, Inc., with Mr. Newton as president and treasurer.

Mr. F. T. Hyndman, as announced in our last issue, has been appointed mechanical superintendent of the New York, New Haven, & Hartford R. R., succeeding F. N. Hibbits, resigned, to go to the Lehigh Valley. Mr. Hyndman was born in 1858 and began railroad service in 1872 in the Ashley shops of the Central R. R. of New Jersey. Later he was an apprentice for three years in the Wilksbarre shops of the Lehigh Valley R. R., and then was brakeman and fireman on the Central R. R. of New Jersey. In 1880 he went to the Atchison, Topeka & Santa Fe Ry. as a machinist, and the next year went to the Pittsburg & Western. From 1883 to 1895 he was engineman on the last named road, and was then appointed trainmaster. A year later he was master mechanic at Allegheny, Pa. In 1902 he went to the Baltimore & Ohio R. R., with the same title, and then to the Buffalo, Rochester & Pittsburg R. R., where he was promoted to be superintendent of motive power. In 1905 he went to the New York, New Haven, & Hartford R. R. as general master mechanic.

SINGLE PHASE EQUIPMENT FOR RICHMOND & CHESAPEAKE BAY RAILWAY.—The Richmond & Chesapeake Bay Railway has under construction about 15 miles of track which will be equipped immediately with single phase apparatus. Eventually this road will extend from Richmond to the Chesapeake Bay, but the portion now under construction comprises that part lying between Richmond and Ashland. The contracts for the equipment of this section have been let to the General Electric Company.

The catenary method of suspension will be used, adapted for a trolley potential of 6,600 volts. Each of the cars will be equipped with four G. E. A-603 (125) alternating current single phase motors. Multiple unit control will be furnished using the Sprague-General Electric system. The air brake system will be of the combined straight and automatic type, with C. P. A-52 motor compressors.

The Richmond & Chesapeake Bay will practically parallel the Richmond, Fredericksburg & Potomac steam road from Richmond to Ashland, and it is the intention of the trolley company to maintain a fast schedule between these two points, operating cars at very frequent intervals.

MASTER CAR BUILDERS' ASSOCIATION.

40TH ANNUAL CONVENTION.

The convention was called to order June 13, in the Sun Parlor on the Steel Pier at Atlantic City, by the president, Mr. Joseph Buker. He presented the following figures indicating the marvellous growth of the railroads during the past forty years, or since the first meeting of the Association was held: "From that little gathering in Springfield, Mass., in May, 1867, at which time there were 39,000 miles of railroad in the United States with 268 engines, 16,135 freight cars and 220 passenger cars, we have grown until, to-day, we proudly make the unchallenged claim of being the greatest association of this kind in the world, with a membership 629 in number. having jurisdiction over 2,047,327 freight cars, valued at approximately $1,037,341,800, which compose the vehicles which move 1,277,771,573 tons of freight, producing a revenue of $1,374,102,275, and 41,981 passenger cars, valued at approximately $251,886,000, handling 716,244,858 passengers, producing a revenue of approximately $456,343,380, and operating over 293,937.42 miles of railroad. This, not including cars owned by individuals or private companies; the value of such freight cars was on June 30, 1904, $72,000,000, and of cars operated by the Pullman Company $51,000,000, or a total of $123,000,000, making a grand total of $1,412,227,800 approximate valuation of passenger and freight cars."

The president called attention to the importance of being properly prepared to solve the problem of the motor car, and also those involved in the substitution of electricity for steam. The construction of cars as well as of draft gear should be carefully studied, in view of the greatly increased tractive power of present locomotives over that of those used a few years ago. That the present rules of interchange are satisfactory is evidenced by the fact that only about a dozen cases were referred to the arbitration committee during the past year. There is still a very great variety of car couplers in use which differ from each other in detail and yet all come within the requirements of the Master Car Builders' Association. The president suggested that the coupler committee should gradually change the requirements so as to finally have a single standard coupler which will fully meet all the requirements of the Interstate Commerce Commission's Safety Appliance Act. The suggestion was also made that the matter of clearances of passenger, freight and locomotive equipment, which will operate over steam roads at present being electrified, should be considered by a committee and some action be taken immediately. The members were urged to not only make a special effort to maintain a high state of efficiency in all of the safety devices now in use, but to exert themselves in inventing, constructing and testing, with a view to adopting, any new devices for improving the efficiency of safety devices and affording greater protection to both the employes and the travelling public, and to do all in their power to co-operate with and assist the Interstate Commerce Commission.

The report of the secretary showed a total membership of 631. The number of cars represented in the Association is 2,047,327. The treasurer's report showed a balance on hand of $5,104.

A resolution to the following effect, introduced by the executive committee, was adopted:

"Whereas, The Master Car Builders' Association has earnestly labored for more than a generation to bring about uniformity in car equipment, and has been aided therein by national legislation, which the Interstate Commerce Commission is directed to execute and enforce, and, in conformity with the rules of the Master Car Builders' Association, the Interstate Commerce Commission has adopted a system of inspection based on those rules, and,

"Whereas, The 77th General Assembly of the State of Ohio, in 1906, passed House Bill No. 242, which, among other things, requires the application of extra sill steps not required by national legislation, the application of which will destroy the uniformity in equipment which is so necessary for the safety of trainmen and the proper interchange of cars; therefore, be it

"Resolved, That the enforcement of such legislation will be subversive of the work of the Master Car Builders' Association, destructive of the uniformity which alone has enabled the traffic of the country to be handled from one end to the other regardless of the ownership of the cars, and, therefore, the Master Car Builders' Association earnestly protests against the enactment or enforcement of legislation by any State which is calculated to destroy the uniformity of equipment so necessary to safety and the expeditious interchange of cars."

The following amendments to the constitution were adopted: "Section 2. Any person holding the position of superintendent of the car department, master car builder, assistant master car builder, assistant mechanical superintendent, mechanical engineer, assistant mechanical engineer, assistant engineer of motive power, chief draftsman, foreman of a railroad car shop, joint car inspector, or one representative from each car manufacturing company, or other company owning or operating over one thousand cars, which are not in process of purchase by other parties, may become an active member by paying his dues for one year." Balance of section to remain as at present. Also, that Section 5, Article II., of the constitution regarding life membership, be modified so that either active or representative members who have been in good standing twenty years may become life members on the recommendation of the executive committee.

Mr. G. W. Rhodes was elected a life member of the Association, and Mr. A. H. Stucki, of Pittsburgh, was elected as an associate member.

Mr. Edward A. Moseley, secretary of the Interstate Commerce Commission, addressed the association. He deprecated the action of the Ohio State Legislature in passing a law conflicting with Master Car Builders' rules and standards. The national law is based upon the rules and standards adopted by the Association. The State has no right to control cars used in interstate commerce. Comment was also made on the improved condition of equipment as regards safety appliances, due to the action of the courts in clearly defining the safety appliance law and to the co-operation of the members of the Association with the Interstate Commerce Commission. The percentage of defective cars to the number of cars inspected was 22.59 per cent. last year as against 31.31 per cent. for the previous year.

Better arrangements should be made for handling bad order cars, and this is especially true of cars without drawbars. The law positively prohibits the hauling of cars chained together, and the commission will file information for violation of the law whenever it finds that chained-up cars have been handled in trains between terminals, and especially where it appears that such cars have been permitted to pass through repair points or terminals. The M. C. B. couplers should be of sufficient flexibility to operate on sharper curves than they do at present. The improper repairs to couplers not only increases the cost of maintenance but is unsafe. This question is of more than ordinary importance from the fact that the employer's liability law, which has just been passed by Congress, does away with the defence of contributory negligence in personal injury cases where gross negligence or disobedience of the law on the part of the employer is shown. The order of the commission increasing the minimum of air brakes in service goes into effect August 1. Roads should issue stringent orders forbiding employees to cut out air brake cars without attaching cards showing defects, and something should be done to improve the condition of retainers. That the suggestions made by Mr. Moseley met with the hearty approval of the Association was indicated by the fact that an enthusiastic rising vote of thanks was extended to him.

COMMITTEE REPORTS.

REVISION OF STANDARDS AND RECOMMENDED PRACTICE.—Mr. C. A. Schroyer (C. & N. W.) presented the report. A letter was read from Mr. O. C. Cromwell (B. & O.) suggesting that the M. C. B. standard axle be changed by substituting a ¾-in. for a ⅛-in. radius between the wheel fit and the rough collar adjoining the inside hub of the wheel, and also increasing the size of the radius between the dust guard and the wheel fit from ⅛ to ¼ in. This recommendation was referred to letter ballot. The recommendation that a committee be appointed to report at the 1907 convention on the height of couplers was adopted and referred to the executive committee. The recommendation that a special committee be appointed to investigate the matter of increasing the length of the arch bars for 80,000-lb. capacity cars was adopted. The question of changing the passenger car journal box and contained parts was referred to the executive committee. The changing of the width of the 5 x 9-in passenger car oil box from 8½ to 9 ins. was referred to letter ballot.

COMPOSITE DESIGN OF COUPLER.—Upon motion of Mr. F. H. Stark, the report of the committee was accepted and the committee discharged.

TEST OF COUPLERS.—Mr. R. L. Kleine (P. R. R.) moved that the recommendation of the committee that they be instructed in accordance with the second proposition contained in the 1905 report be approved. Carried.

CAST-IRON WHEELS.—Mr. R. L. Ettinger (So. Ry.) explained that the increase in the thickness of the flange on a line with the top of the rail was really less than 1-16 in., and that a taper of 1 in 20 had been experimented with by some roads with satisfactory results as regards flange wear. The matter of increasing the radius at the throat of the flange from 11-16 to ¾ or ⅞ in. was discussed, but the general opinion was that since this depended on the rail section, 11-16 in. was about as much as could be allowed by the American Railway Association. The report of the committee was accepted and referred to letter ballot as recommended practice.

TRIPLE VALVE TESTS.—The report was accepted and the recommendations to the effect that the testing plant at Purdue be overhauled and arranged to accommodate 100 triple valves, and that a new code of tests be formulated, were adopted.

BRAKE SHOES.—Mr. R. P. C. Sanderson (S. A. L.) suggested that the committee should give more definite information as to the nature of the material in each shoe. Dr. Goss replied that the shoes were preserved at Purdue, and that a complete analysis could be made of the various shoes, although it would be rather expensive. A motion was carried to the effect that the committee be instructed to investigate and report on a maximum coefficient of friction; also, if desirable, to recommend a change in the minimum coefficient and the coefficient at a point 15 feet from the stop. The recommendation that the testing machine be equipped for determining the wearing qualities of the shoes was referred to the executive committee for action.

BRAKE BEAMS.—This valuable report drew out a lengthy discussion, and was finally referred to the committee on standards. In introducing the report Mr. A. E. Mitchell explained that the tests were not made to determine the relative strength of the beams, but to enable the committee to prepare a proper specification. For this reason no attempt was made to test all of the beams now on the market. Mr. Nathan H. Davis, of the Davis Pressed Steel Company, suggested that the proof load should be 50 per cent. in excess of the capacity in order to eliminate all lost motion. He also advised that a distance of 9½ ins. from the centre of the pin hole to the back of the beam could not be met by their beam. Prof. H. Wade Hibbard gave a practical demonstration of the fact that the distance of the lever pin hole in front of the brake shoe is a very important dimension. If it is made too small the tendency will be for the beam to buckle sidewise. The discussion developed the fact that a beam measuring more than 9½ ins. from the centre of the pin hole to the back of the beam could not be used in a large percentage of cases, and also that certain beams could not be made with this dimension as low as 9½ ins. On the other hand a standard distance is very desirable in order that the railroads may carry a standard bottom connecting rod. Mr. W. E. Fowler suggested that the standard length of beams be made 60 ins. and that no variation be allowed from this. An amendment made by Mr. A. E. Mitchell, was carried to the effect that the recommendation requiring that the brake hangers shall be attached to the brake head at the centre just back of the central brake shoe lug be changed to allow a brake hanger to be placed 2½ ins. above the centre line for beams of I or solid section. Mr. R. F. McKenna (D., L. & W.) suggested that the minimum thickness of the metal in the jaws of the fulcrum be made ¾ in. Mr. J. J. Hennessey (C. M. & St. P.) strongly advocated the adoption of a brake beam of standard dimensions.

AXLE LIMITS.—After an extended discussion this report was adopted. While it was admitted that stenciling the car with the light and maximum weights would prove of considerable advantage from the view point of the traffic department, yet there was some question as to how it would affect the working of the rules of interchange.

INTERCHANGE RULES.—The decisions made by the arbitration committee during the year were endorsed by the convention. Very few changes were made in the rules by the arbitration committee and they were adopted without discussion.

PRICES OF REPAIRS TO STEEL CARS.—The report was adopted.

REVISION OF PASSENGER CAR RULES.—These were adopted with one or two slight changes.

REVISION OF RULES FOR LOADING LONG MATERIALS.—A spirited discussion took place on the clause limiting the height of superimposed loads to 9 ft. 3 in. The report was finally adopted after substituting the old clause for this height limit.

LOCATION OF TEMPORARY STAKE POCKETS.—Referred to letter ballot.

AIR-BRAKE HOSE SPECIFICATIONS.—The report was accepted and the committee continued. The recommendation that a committee, composed of several railroad chemists, give the matter of chemical analysis a thorough investigation was referred to the executive committee. The discussion served simply to bring out more forcibly the fact that the present physical tests, while they are useful in determining the strength of the hose are of little value as a basis of determining its durability.

HIGH-SPEED BRAKES.—The report was accepted without discussion and the committee continued for another year.

THIRD-RAIL CLEARANCES.—On the first day of the convention a committee was appointed to consider and report on this subject during the convention. The committee did not have time to draw up a written report, and Mr. F. M. Whyte presented a verbal report, reproduced on another page of this issue, outlining a report which, it was understood, would be drawn up by the committee in time for publication in the proceedings.

HEIGHT OF BRAKE STAFF.—The committee failed to submit a report, and a motion was carried that a committee of three be appointed to work in connection with a committee already appointed by the General Managers' Association to determine the height of brake staffs for box and other cars.

AUTOMATIC CONNECTORS.—The discussion of the report developed the fact that there had been a misunderstanding as to the patents on the side-port coupler. The patents covering the general principle of both the side-port and butt connectors have expired, and the existing patents cover only special features of these two types. After a spirited discussion a motion was made that the committee be instructed to continue its work and prepare standard dimensions for automatic couplings for steam-heat, air-brake and air signals, also to fix the relative location and dimensions of the different parts, so

that as cars are equipped from time to time with such automatic couplings the various makes will be interchangeable, one with another; the committee to report at the next convention. This leaves the committee free to consider either type of coupler.

LOCATION OF SIDE AND END LADDERS ON BOX AND STOCK CARS.—The recommendation in the report was amended to read that the committee on standards be instructed to modify the M. C. B. sheets and rules covering the location of grab irons to show the roof grab irons parallel to the side or end of the car on which the ladders are erected, these grab irons to be placed not less than 15 ins. from the edge of the car, and of length to suit the construction of the car. This was referred to a letter ballot.

TANK CARS.—The report was accepted and referred to letter ballot, together with the following recommendations: Mr. A. W. Gibbs (P. R. R.) suggested that each type of tank car be examined by its home road to see whether it conforms or is equal to the minimum requirements. If it does, the home road is to stencil it to show that it has been examined and passed. Mr. R. L. Kleine (P. R. R.) amended Mr. Gibbs' suggestion to the effect that the committee prepare a stencil, to be submitted to letter ballot with the report, together with specifications as to the location of the stencil on the car.

TOPICAL DISCUSSIONS.*

CIRCUMFERENTIAL VARIATION ALLOWABLE IN MATING WHEELS.—The discussion, opened by Mr. G. L. Fowler, did not bring out any statement as to the exact amount of variation allowable. It is, of course, desirable to mate the wheels as closely as possible and, while a difference in size may cause sharp flanges, it is only one of a number of other causes, and they probably often neutralize each other.

PIECE-WORK ON FREIGHT CAR REPAIRS.—Mr. Le Grand Parish opened the discussion as follows: Piece-work in the car department is in such general use at the present time that little can be said which will be of interest to the Association other than calling attention to the benefits to be derived from its introduction. Much has been written about the management of piece-work and the various methods of price making, all of which is available for the use of the members, therefore, I will only mention some of the benefits which may reasonably be expected. First, and most important, is the increased car service. If we figure the earnings of freight cars, at a reasonable rate per day, the saving on this item alone will nearly pay the total labor charge, as the time on the repair tracks for heavy repairs is reduced nearly one-half. By practically doubling the capacity of the repair tracks the need for increased track facilities and congestions under day work system are relieved, and it naturally follows that the cost is reduced and earnings of the men increased, bringing about a desirable labor condition.

This system automatically betters the shop organization in general, brings about better methods of store-keeping, improving the design of equipment, calling attention to lack of proper shop and repair track facilities, and, in fact, is the only true measure of shop output. What has been said of freight car repairs is equally true of passenger car repairs. Too much cannot be said in favor of this system in the various departments of car shops. In order to bring about these conditions, however, it is necessary to have experienced piece-work supervision when the system is introduced.

ADVISABILITY OF SPLICING CENTER SILLS.—This discussion was opened by Mr. F. H. Stark, and referred to cars of 50,000 lbs. or less capacity. He called attention to the fact that the rules allowed the splicing of only one center sill. Both sills are usually damaged at the same time, and nothing could be gained by splicing one sill in such a case. The discussion which followed indicated that spliced sills on all classes and capacities of cars are giving good results and coming into general favor.

The following officers were elected: President, W. E. Fowler, Canadian Pacific; vice-president G. N. Dow, L. S. & M. S.; second vice-president, R. F. McKenna, Lackawanna; third vice-president, R. W. Burnett, Erie; treasurer, John Kirby; executive committee—J. F. Walsh, F. N. Hibbits, F. T. Hyndman.

*The remaining topical discussions will be reviewed in our next issue.

FOUR-CYLINDER BALANCED SIMPLE LOCOMOTIVE.

To the Editor:

In the course of the interesting description of the Belgium State Railway, 4-6-0 type, four-cylinder balanced, single-expansion superheated steam locomotive, which appears on page 217 of the current issue of your paper, the following passage occurs: "All the cylinders are connected to the front pair of drivers, which has a built-up crank axle. The connection is such that the two cylinders on the same side of the engine are at 180 deg. with each other, and at 90 deg. with the corresponding cylinders on the opposite side. Inasmuch as all moving parts in both cylinders and the main rods are exact duplicates, it follows that this connection gives an *absolutely perfect balance* on each side of the engine. (The italics are mine.)

I beg to direct attention to the fact that this latter statement is quite incorrect, for although the above arrangement of the mechanism unquestionably reduces its dynamic disturbances to a minimum, it is nevertheless utterly impossible to obtain a *perfectly* balanced locomotive, owing to the difference in the net horizontal inertia forces of the reciprocating parts and connecting-rod at the two ends of the stroke, which inequality is produced by the combined effect of the angularity and the centrifugal force of the connecting rod.

Thus, consider the case of a locomotive of the above design, in which the reciprocating parts and connecting rods for the four cylinders are identical, and assume that the weights and dimensions of these parts coincide with those for the high-pressure cylinders of the Cole balanced Atlantic type locomotives, referred to in my paper on the "Comparative Magnitude of the Longitudinal Disturbing Forces in a Cole Balanced Compound and a Single Expansion Express Locomotive," published in the AMERICAN ENGINEER AND RAILROAD JOURNAL for December, 1905, page 447.

In this article it was demonstrated that for the Cole locomotive, when at a speed in miles per hour equal to the driving wheel diameter in inches, viz.: at 80 m.p.h., or 336 r.p.m., the stresses on the high-pressure crank-pin at the dead points, due to the inertia of the reciprocating parts and the connecting rod, are 46,960.7 lb. and 42,978.5 lb., at the front and back dead centers, respectively. Consequently, even if the reciprocating parts and connecting rods of the low-pressure cylinders were exact duplicates of those for the high-pressure, there would still be an unbalanced forward inertia force of 46,960.7—42,978.5=3,982.2 lb., or nearly 2 tons, on each side of the engine at the ends of the stroke, which it is entirely impossible to neutralize.

The foregoing remarks should not be construed as an adverse criticism of the Belgium State Railway locomotive. On the contrary, I have for some time past been decidedly of opinion that this general type of engine, i.e., a four-cylinder balanced, single-expansion locomotive, with a boiler pressure not exceeding about 200 lb. per sq. in., and using highly superheated steam, will probably be the representative heavy American express locomotive of the future; the validity of which opinion is to some extent confirmed by the fact that for more than a year the motive power department of one of our most important railroad systems has considered the advisability of designing such a locomotive, and is now conducting an elaborate series of experiments that may be regarded as preliminary thereto.

The purpose of the present communication is merely to correct the prevalent erroneous impression that a locomotive of this description can be perfectly balanced in a longitudinal direction.

EDWARD L. COSTER,
Assoc. Am. Soc. M. E.

25 Broad Street, New York,
June 12, 1906.

LUSITANIA.—The new Cunard Line steamer Lusitania, the world's largest liner, was successfully launched at Glasgow, Scotland, June 7. The vessel is 790 feet long, its greatest breadth is 88 feet, and its displacement is about 40,000 tons. Turbine engines will drive it at an expected speed of 24 to 25 konts.

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase of construction.*

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In many respects the Master Mechanics' and Master Car Builders' conventions held at Atlantic City have been the most successful in the history of these associations. Never have the meetings themselves been better attended. The reports and papers presented before both associations were specially good, and in several cases indicated a greater amount of research and investigation than is usually devoted to such reports. The exhibit space occupied was almost twice as large as that for the Manhattan Beach conventions. There is one thing, however, that must be criticized, and that is the noise about the "Sun Parlor" in which the meetings were held. For years, or ever since the exhibits have amounted to anything, they have been placed near the meeting room, and the noise and racket, especially at the opening meetings, has been very annoying. The same thing was true this year, and was augmented by the squeaky chairs which were provided. Railroad men, as a rule, are not trained orators, and the noise going on about them not only prevented them from being heard by members in different parts of the room, but it served to disconcert the speaker. When the importance of the work which is being done by these associations is considered, it seems a shame that better facilities are not provided for carrying on the meetings, and it is to be hoped that some action will be taken by the executive committees and the Supply Men's Association which will obviate these conditions at future conventions.

THIRD-RAIL CLEARANCES.

A committee was appointed at the first session of the Master Car Builders' Association to report during the convention on the subject of third-rail clearances. The committee did not have time to draw up a formal report, but Mr. F. M. Whyte, general mechanical engineer of the New York Central Lines, made a verbal report outlining the report which the committee would prepare in time for publication in the proceedings. Mr. Whyte's remarks are reproduced on another page of this issue. Special attention was directed to the fact that that part of the clearance diagram relating to the third rail must be considered in a different light from the remaining part of the clearance diagram. The third rail is located the same distance from the running rail on curves as on tangents, and in designing cars and locomotives it is necessary to keep far enough inside of the clearance lines to allow for curvature, and for the horizontal and vertical movements in the following tables. The offsets at the middle on a 20-deg. curve for cars of various distances between truck centers are as follows, the 20-deg. curve being referred to because the New York Central will have such curves.

Distance Between Truck Centers in Feet.	Offset in Inches.
20	2¼
22½	2¾
25	3⅜
27½	4⅛
30	4¾
32½	5⅝
35	6½
37½	7½
40	8½
42½	9½
45	10⅝
47½	11⅞
50	13⅛
52½	14½
55	15⅞
57½	17⅜
60	18⅞

The horizontal movement will amount to as much as 3½ ins. and the vertical to as much as 4⅞ ins., as shown by the following tables.

HORIZONTAL MOVEMENT.

Wear on axle collar	9/16 in.
End play on brasses	⅛ "
End wear on brasses	¼ "
Wear on wheel flanges	⅜ "
Clearance between new flanges and rail	3/16 "
Wear of rail	½ "
Construction variations	1 "
Variation in location of third rail	½ "
Total	3½ in.

VERTICAL MOVEMENT.

Wear on journals and brasses	¾ in.
*Radial wear on wheels	¼ "
Compression of springs	1⅜ "
Constructional variation	1 "
Sagging at centre of car	1 "
Variation in height of third rail	½ "
Total	4⅞ "

This is for cast iron wheels. For steel tired wheels will be greater.

The indications are that portions of several large roads will be electrified within the next few years, and it is important that rolling equipment which is designed for general interchange shall clear these third rail installations, and in view of the foregoing it will be understood that the part of the usual clearance diagram, which provides for the third rail must be given different consideration from that given the remainder of the diagram.

MASTER MECHANICS' ASSOCIATION.

THIRTY-NINTH ANNUAL CONVENTION.

The meeting was called to order by the president, Mr. H. F. Ball. His address, which is of more than ordinary importance, is reproduced in full on another page of this issue. The rapid progress made during recent years was briefly reviewed, and the problems to be solved by the motive power department at the present time were considered. The address is one of the most valuable which has ever been presented before the Association, and is deserving of careful study by all those interested in the work of the mechanical department.

The secretary's report showed the membership as follows: Active, 777; associate, 17; honorary, 40; total, 834. The treasurer's report showed a balance on hand of $1,870.79.

A letter was read from Mr. A. J. Cassatt, president of the Pennsylvania Railroad System, thanking the Association and acknowledging the valuable assistance rendered by its representatives—Mr. F. H. Clark, Mr. C. H. Quereau, Mr. H. H. Borghan and Mr. F. M. Whyte—as members of the Advisory Committee for the locomotive tests made at the Louisiana Purchase Exposition.

The executive committee proposed several changes to the constitution. These relate to the method of electing officers and the requirements for active and honorary membership. They will be acted upon next year.

COMMITTEE REPORTS.

SHRINKAGE ALLOWANCE OF TIRES AND DESIGN OF WHEEL CENTERS.—Mr. G. W. Wildin (Erie) objected to the lip or projection on the outside of the wheel center recommended by the committee because of the difficulty in shimming a tire. Mr. G. L. Fowler suggested the advisability of increasing the carbon in the tire, making it harder, and thus overcoming the tendency toward rolling out or stretching of the tire. Several members advocated using either retaining rings or a projection as recommended by the committee as a matter of safety. Mr. H. H. Vaughan (C. P. R.) suggested that the bulk of the metal in the spoke be placed directly in line with the center of thrust on the tire. This has been done on the Canadian Pacific Railway by making the spokes of pear-shaped section, reducing the section very considerably on the outside. The wheel is easily molded, and the design is more rational than the one suggested. He also advocated making the rim of a deep U shape. This requires no more metal than the section recommended and is much stronger, thus supporting a thin tire better. Where rims are cut they should be fitted with cast-iron spacers, and not soft metal. Mr. P. Maher (I., I. & I.) advocated the use of retaining rings as a matter of safety, and described a retaining ring he is using which is put on in sections, leaving space between each section for shimming. Mr. D. J. Durrell called attention to the action of the brakes in loosening the tires.

FLEXIBLE STAYBOLTS.—Mr. Max Wickhorst (C., B. & Q.) brought out the fact that the experiments made by the committee were with clean firebox sheets and staybolts. The deflections would probably have been greater if they had been covered with scale. Mr. J. F. Walsh (C. & O.) said that they had about 15,000 flexible staybolts in about 210 engines which were giving splendid results. Two thousand five hundred of these were of the type shown on Fig. 4 of the report and the others Fig. 7 (Tate), 22 of Fig. 4 had failed in an engine after 23 months' service. Mr. A. E. Mitchell (Lehigh) said they had introduced 40,000 of the bolts shown in Fig. 7 during the past two years and had not had a single failure. Mr. D. J. Durrell (P. R. R.) said that where they had installed water purifying plants no failures of flexible staybolts had occurred in the past two years. Mr. G. W. Wildin said it was impossible to say in just what portion of the firebox the bolts were most liable to break, and advocated applying them wherever the boiler fittings would permit. Mr. D. J. Redding (P. & L. E.) said they had several locomotives equipped with the bolt shown in Fig. 7, and that it was giving good results. Mr. C. H. Doebler (Wabash) spoke of the value of the flexible staybolt for overcoming the tendency toward cracking the side sheets. The life of side sheets had been increased from 11 months to 3 years on this road, due to the use of flexible staybolts.

LOCOMOTIVE TESTS OF THE P. R. R. AT ST. LOUIS.—This report consisted of abstracts from the results of each of the tests and the summary of conclusions as given in the bound volume of results issued by the Pennsylvania Railroad Company. It was moved and carried that the report be received with thanks, the committee discharged, and that the Committee on Resolutions be instructed to prepare a memorial to the Pennsylvania Railroad showing the appreciation of the Association of the work accomplished.

WATER SOFTENING FOR LOCOMOTIVE USE.—Mr. G. R. Henderson called attention to the mention that alkali waters could not be successfully treated and stated that such waters could be distilled and thus made satisfactory for locomotive use. This would cost from 10 to 12 cents a thousand gallons. Mr. C. E. Fuller (C. & A.) gave his experience with the mechanical process mentioned in the report and stated that it was an entire success and that all engines having cylinder diameters of 19 ins. or over on the C. & A. were equipped to use this system. This had been done only after careful trial. As an example of the results attained he mentioned that flues which previously ran only 35,000 miles and firebox sheets which failed in 9 months were now being run 80,000 to 95,000 miles and from 24 to 36 months. The tonnage had been increased 27 per cent. with same engines on same division. Roundhouse work in connection with boring cylinders, facing valves, new rings, etc., had been practically eliminated. Roundhouse force takes care of the blowing off of the engines. It was further stated that this oil system required careful attention, but had given very gratifying results in every way.

Mr. D. J. Durrell stated that he had found that one purifying plant on a division would neutralize the waters of adjacent stations and show a material decrease of boiler troubles over the whole division. Roundhouse work had been reduced from 25 to 45 per cent. by the use of purified water. Other members stated that purified and treated water had resulted in very substantial reductions of boiler and roundhouse work. Mr. J. F. Walsh called attention to the results he had obtained in improved boiler conditions by the use of a hot water washing out system.

LOCOMOTIVE FRONT ENDS.—The report of this committee was given in these columns in June, page 228. It was read by Mr. H. H. Vaughan, who interposed explanations at several points, calling attention to the curious results obtained on the length of front end and to the diagrams showing the best combination of each arrangement experimented with. Mr. C. H. Quereau called attention to the fact that but 50 per cent. of the draft was utilized back of the present design of diaphragm and suggested that the matter be investigated with a view of devising a better form of diaphragm. Mr. Vaughan explained that the draft pipe was a good thing when the arrangement of the front end was not proper, but that with the correct proportions as given in the report a draft pipe would show no improvement. He said that while the tests were made without a netting, its introduction would simply mean more obstruction and require a smaller nozzle to obtain the same draft. Concerning tests on a new design of diaphragm suggested, Mr. Vaughan did not think this would be possible at Purdue. He agreed with Mr. Menzel that a draft pipe could be used to advantage in getting the proper distribution of draft, but it would lessen its amount when used with the front end suggested. Mr. F. M. Whyte stated that a number of locomotives on the New York Central had been fitted with the design of stack recommended and that it had been possible to use a larger nozzle with equally good steaming qualities. On motion of Mr. A. M. Waitt the thanks of the Association were tendered to the committee, Dr. Goss, Prof. Teague and his associates of Purdue University, for their able work in this connection.

MECHANICAL STOKERS.—The report was read and the committee continued.

CLASSIFICATION OF LOCOMOTIVE REPAIRS.—In the discussion Mr. H. A. Gillis (Amer. Loco. Co.) stated a number of cases showing that the output of a shop was not a proper gauge of the condition of the power, and said that he considered the cost of maintenance per mile or ton mile, to be a much better basis. Mr. Curtis explained the system in use on the L. & N. which is working satisfactorily. This consists of basing the output of a shop on the cost of repairs turned out. Thus, Class 1 repairs cost $100, Class 10 repairs, $1,000, etc. Mr. Quereau advocated the cost per ton mile as the proper basis for comparison. Mr. Vaughan in closing the discussion said that he did not consider the ton mile basis as of any use in locomotive repairs and advocated the 100 per cent. engine mile basis explained in the report. As a supplement to this for rough definition of a shop output he advocated the 1, 2 & 3 system of classification. It was moved and carried that 24 hours be adopted as the limit distinguishing between engines in service and those under repair and that $100, estimated labor charge, be adopted as the limit distinguishing between running and shop repairs.

ENGINE HOUSE RUNNING REPAIR WORK ON LOCOMOTIVES.—No discussion in accordance with motion carried that because of short time all reports of which committees were not present should be read by title only and discussion closed.

LOCOMOTIVE LUBRICATION.—The topical discussion of "Grease vs. Oil in Driving Box Cellars," was included in the discussion of this report. Dr. Goss read a report of some tests he had made which showed that the loss of power resulting from friction was increased by the use of grease as compared with oil. The seriousness of this loss depended largely on comparison, as it seemed to be a constant quantity of about 1,000 lbs. draw-bar pull. The sentiment seemed to be almost universal in favor of grease, which in a large number of cases was shown to largely reduce hot bearings, both pins and journals. Mr. Wildin gave some figures of the comparative cost of lubricating with grease and oil, which showed that the former cost 2.5 cents per pound per 1,000 miles and the latter 31 cents per journal per 1,000 miles. Several members had noticed a slightly increased coal consumption upon the adoption of grease, but none had had to reduce tonnage. The recommendations of the committee in regard to standard parts were referred to letter ballot and the committee continued.

THE USE OF CAST IRON IN CYLINDERS.—The committee was instructed to submit to the executive committee definite specifications with a modification in the limits for silicon. This to be submitted to letter ballot.

ELECTRICITY ON STEAM RAILROADS.—Mr. Henderson called attention to Mr. Wilgus' remarks before the New York Railroad Club to the effect that the incidental costs of arranging terminals, etc., for obtaining the full advantage of electric service was about three times the cost of equipping the track and trains. Mr. McKeen spoke of the necessity of having very heavy and strong cars for electric or motor cars in regular steam service. Mr. Street stated that the average cost of operation for all the electric lines in U. S. was 12½ cents per car mile. On one of the heaviest elevated railroads in the country the motor cars run 65,000 miles between shoppings and at that time the average cost of repairs per motor was between $2 and $3. Mr. Vaughan considered the motor car question a very live one. He thought a car should carry more than two men unless it was in strictly branch line service, where there was sure to be but one car on the line. This third man could as well be a fireman as a brakeman. The question of strength is important. He briefly described a car recently put into service on the C. P. R., which ran by steam furnished by a Scotch boiler fired with oil. It weighs 130,000 lbs. total. It was found that data and proportions relating to locomotive practice were adaptable to the steam plant on this car. The cost of operation is between 15 and 20 cents. Oil consumption is about 1.8 gal. per car mile.

INDIVIDUAL PAPERS.

VALVE GEARS FOR LOCOMOTIVES, BY C. J. MELLIN.—The discussion developed the fact that Mr. J. H. Manning (D. & H.) is conducting a test comparing three 10-wheel freight engines, one equipped with the Young valve gear, one with the Allfree-Hubbell and one with Stephenson motion and Richardson valves. Mr. D. J. Redding (P. & L. E.) said that their 19 x 26-in. passenger engines equipped with the Allfree-Hubbell gear were hauling trains formerly hauled by 20 x 26-in. simple engines.

THE MODERN LOCOMOTIVE INJECTOR.—The paper was read in abstract by its author, Mr. Strickland L. Kneass.

WELDING AND REPAIRING LOCOMOTIVE FRAMES.—On account of the absence of its author this paper was not read.

SUPERHEATED STEAM ON AMERICAN LOCOMOTIVES.—On account of the absence of its author this paper was not read.

FIRE KINDLING.—No discussion because of lack of time.

ELECTION OF OFFICERS.—The following named officers were then elected: President, J. F. Deems, New York Central; first vice-president, William McIntosh, Central of New Jersey; second vice-president, H. H. Vaughan, Canadian Pacific; third vice-president, G. W. Wildin, Erie; treasurer, Angus Sinclair, Locomotive Engineering; executive committee, F. H. Clark, C. E. Fuller, T. H. Curtis, F. M. Whyte.

(*The Topical Discussions will be reviewed in our next issue.*)

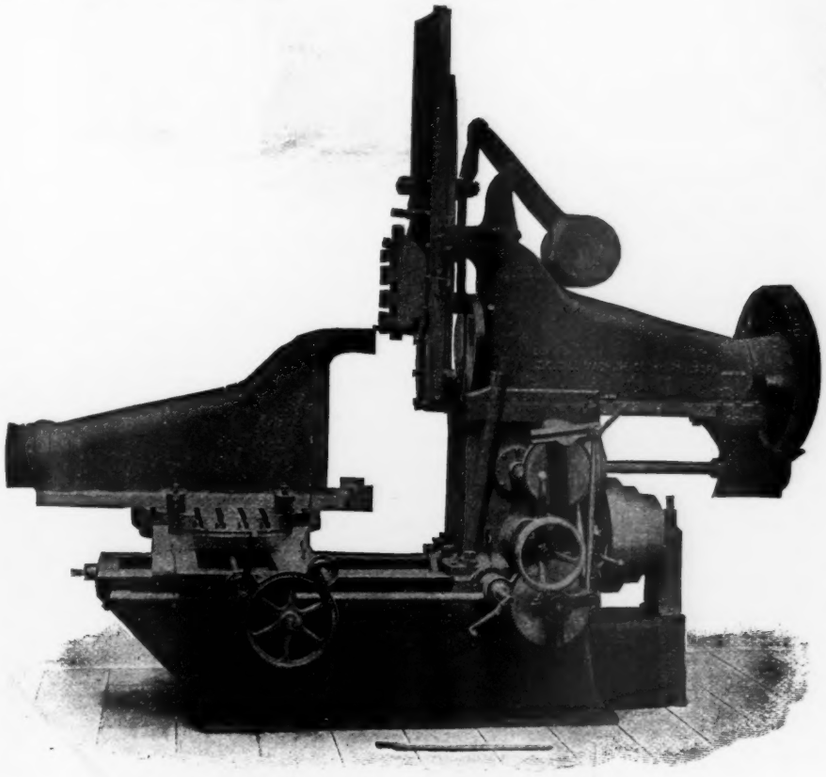
SUPERHEAT AND THE LOCOMOTIVE.—Superheating does not seem to be antagonistic to compounding, but it serves in the same general direction to reduce heat losses in the cylinders. Condensation of steam in locomotive cylinders and passages robs the locomotive of a great deal of its power, and in cold climates this becomes a serious matter. It will always be difficult to thoroughly protect the cylinders and steam passages from radiation, and therefore other precautions may be necessary to prevent the loss of heat from lessening the power of the locomotive. Superheated steam, coming into the cylinders at high temperature as it does, permits of a larger loss of heat before producing condensation than is possible with saturated steam, where the margin for loss without condensation is very small. Superheated steam may lose to the cylinders and passages a much larger proportion of its heat before condensing, and in this lies the chief advantage of its employment. Superheated steam is also quicker than saturated steam in its movements through passages and ports, as is proven by the fact that in Germany 7-in. piston valves suffice for ordinary passenger locomotives.

Such a principle as this cannot be applied to a locomotive without incurring some trouble and expense. While the improvement in the efficiency and economy of the locomotive is very readily attained, it is quite possible that it may be attained at too great an expense of restricted mileage and cost of maintenance, and it is always necessary to nurse a new development in order to make it practically successful. The possibilities of superheated steam at the present time seem to be exceedingly important, and it is perfectly safe to spend the time and money necessary for experimenting because of the practical certainty of the results.—*Mr. G. M. Basford, at Purdue University.*

INSPECTING CARS ON A PIECE-WORK BASIS.—In the car department on the New York Central every shop is now under piece-work. We are doing our inspecting at Exchange Street, Buffalo, by piece-work. I know of no other road in the country that has, as yet, attempted this. Every movement, even putting on a brake shoe, changing an air hose, and all the details, are done on a piece-work basis, and I have no doubt we will extend it throughout the system.—*F. W. Brazier, New England Railroad Club.*

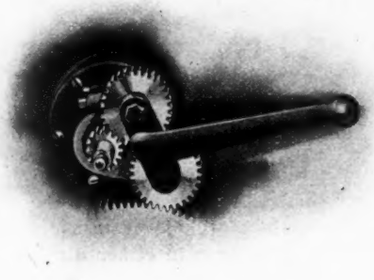
THE DILL SLOTTER.

The design of the Dill slotter differs radically from that of the ordinary type of slotting machine, as may be seen by referring to the illustrations. The manufacturer's claims for this machine are that it is able to produce a greater amount of work, that the work is more accurate and that it has a much greater range, and is not confined to the class of work usually handled by such machines. The most noticeable feature of the design is the travelling head. This head may be clamped rigidly in any position, or as the feeds operate on the head it may be fed to such work as is too cumbersome to be fed to the tool. On work not requiring an extended reach



AN AWKWARD PIECE OF WORK EASILY HANDLED ON A DILL SLOTTER.

the ram may be brought back close to the column, making it very rigid. When the cutting bar is in this positon and the table is brought forward to its limit the outside of work of very large diameters may be machined. The upward thrust is taken by the two large bolts, one on each side, which tie the bed, column and head together and are anchored in the

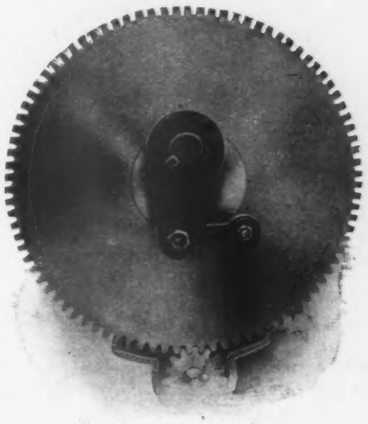


QUICK TRAVERSE GEAR.

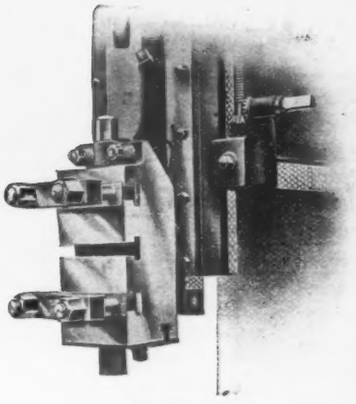
bed. Additional support is given to the frame when the ram is extended by the standard back of the column mounted on an extension of the bed, which has a sliding contact with the head when the latter is extended.

The head and compound table may be moved quickly in all directions by power by means of the quick traverse gear shown in one of the illustrations. This saves considerable time and labor in setting work to a line or to a surface already machined. This feature will also be appreciated in setting the tool in position for a second cut; this may be done while the machine proper is in motion or at rest. The gears are arranged to force themselves out of mesh if they are subjected to excessive strains, thus protecting the machine.

One of the illustrations shows the general construction of the quick return. The main driving gear moves in a path



QUICK RETURN.

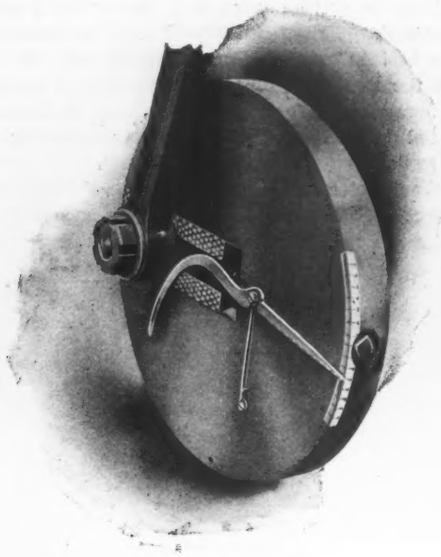


RELIEF APRON.

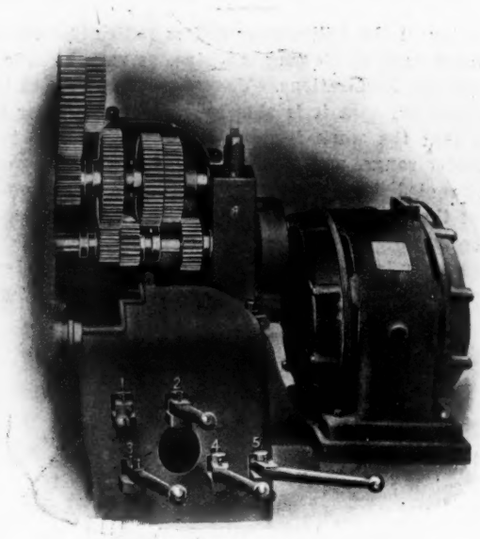
eccentric to the crank shaft, and is connected to it by a crank and a steel link instead of the usual sliding block, thus eliminating considerable friction in addition to obtaining a more uniform cutting speed. The quick part of the movement takes place at the lower end of the stroke, a point where there is but slight movement of the ram, and where there is always an excessive dwell; considerable time is thus saved, and as it takes place when the reciprocating parts are nearly at rest, it is possible to obtain a higher cutting speed than would otherwise be possible.

The feeds are operated without the use of cams, and the feed is quick and positive with a slow start. The construction is such that either intermittent or continuous feeds may be used, according to the class of work, it being possible to readily change from one to the other. The feed mechanism is protected by a safety device, so that if the head or table meets with an obstruction or undue resistance it will throw itself out of gear without injury to any part. This device is specially valuable for duplicate work, as stops may be placed to throw the feed out at any predetermined position.

The machine is equipped with a stroke indicator indicating the amount of stroke the machine is set to. This feature will be appreciated by those acquainted with the difficulties usually met in adjusting the stroke on slotters. The table is rigidly secured to the cross saddle by four corner clamps. The longitudinal saddle supports the cross saddle the full



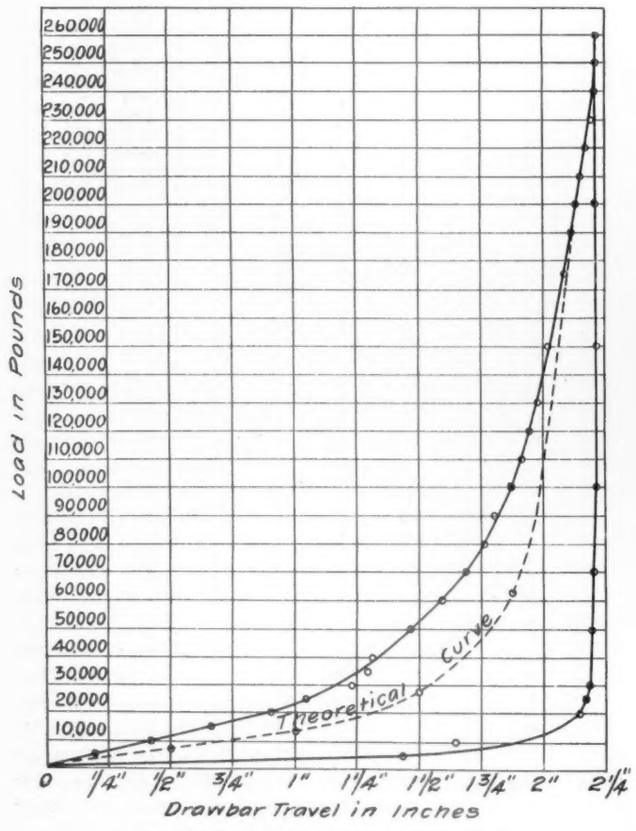
STROKE INDICATOR.



CONSTANT SPEED MOTOR DRIVE—DILL SLOTTER.

width, which is an important feature when the outer surface of the table is used much. The table is graduated in degrees, and by the aid of the quick traverse gear may be quickly and accurately set to any angle.

The ram is fitted in an adjustable guide, which may be raised or lowered by a convenient crank handle to positions where it can best support the ram. It is also provided with



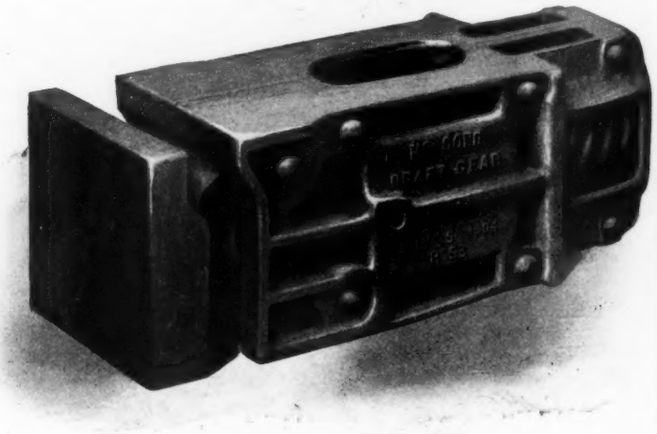
COMPRESSION TEST—MCCORD DRAFT GEAR.

a relief apron hinged to the ram, well back and very low down, kept in place by two studs at the top by which it may be clamped rigidly to the ram, or permit the spring tension to be regulated to suit the work. Six changes of speed may be obtained either with a one-speed countershaft and three-step cone pulley or by a constant speed motor application, as shown in one of the illustrations. If desired, variable speed motors may readily be attached. These machines are made by the T. C. Dill Machine Company, Inc., Philadelphia, Pa.

McCORD DRAFT GEAR.

A draft gear designed on an entirely new principle has recently been perfected by McCord & Company, of Chicago, and is illustrated herewith. This gear, while it employs the use of a coil spring, cannot be classed as a spring draft gear, nor is it a friction gear, although friction unavoidably enters somewhat into its operation.

The basic idea in the design is the use of the movable fulcrum on a lever, the ends of which receive and resist the

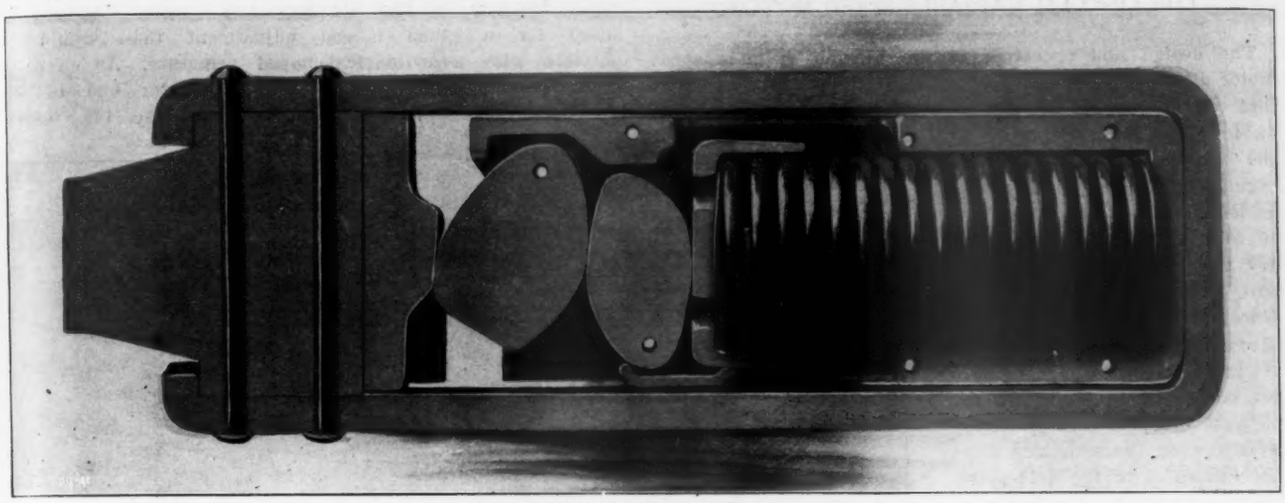


McCORD DRAFT GEAR.

shock, i. e., the coupler acts against the end of one arm of the lever, the movement of which is resisted by a spring at the other end, and the fulcrum governing the length of the two arms of the lever changes its position with the movement, so as to increase the ratio of the lever arms in favor of the spring, as the position changes in either direction. The construction is such that the leverage against which the spring acts is twelve times as great at the end of 2⅛ ins. movement of the coupler as it was at the beginning.

In order to get the device into a compact and practical form for application to cars this single lever is made in the form of two cam-shaped levers, and the variation of the leverage is secured by shaping these cams so that in rocking one upon the other the leverage is increased in practically the same way.

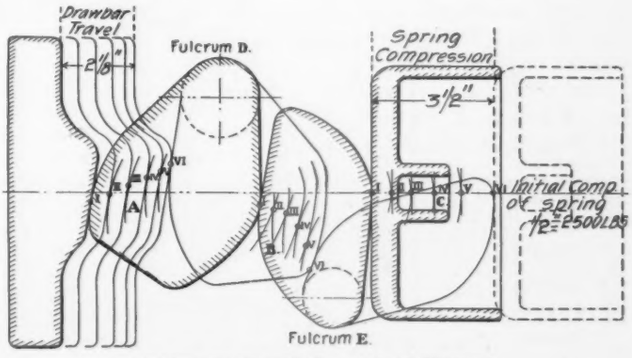
The cross-section shown herewith gives a clear idea of the location and shape of these cams and of the coil spring back



MCCORD DRAFT GEAR—SECTION SHOWING CAMS.

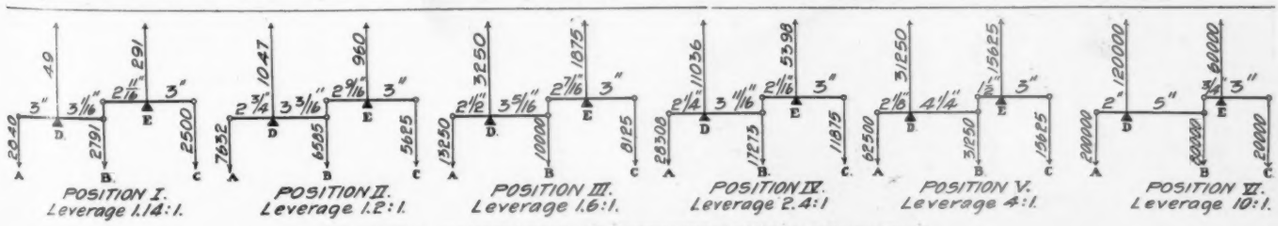
of them. It will be seen that the whole arrangement takes up comparatively little space, and that as assembled for use it comprises but few parts. The casing around the whole gear is formed by two malleable iron castings which have shoulders at the rear to take the place of the rear follower plate. The front follower plate of cast steel is constructed with a projection of special shape bearing against the first cam. The cams themselves are of steel and made as broad as the width of the yoke will allow. They swing upon pins which, as will be seen by a careful examination of the whole gear, carry but little stress, and hence are of light section. The spring is put into place with a ½-in. initial compression, equivalent to about 2,500 lbs., thus taking up all of the lost motion of the gear.

By reference to the diagram showing successive positions of the cams and the graphical illustration of the leverages, it will be seen that the resistance to the load at the start is comparatively light, and that it gradually increases in an increasing ratio as the coupler moves. This gives an elasticity to the gear until the load is increased beyond ordinary service conditions and up to the maximum draw-bar pull of present locomotives. After this point is reached the resistance increases very rapidly until the capacity of the gear is exhausted. The load applied to the front follower plate works through a leverage equal to the vertical distance between its point of contact and the fulcrum of the first cam which, it will be seen, gradually shortens as movement increases. The resultant works through a leverage equal to the vertical distance between fulcrum D and the point of contact between the two cams which, it will be seen, gradually increases with the movement. This force acts in turn upon a lever arm equal to the vertical distance between the point of contact between the two cams and the fulcrum E, which decreases with the movement in proportion as the other arm increases. This resultant force in turn acts against a lever arm equal to the distance between the point of contact of the second cam with the spring cap and the fulcrum E, which remains constant. This compound leverage has been worked out graphically, and is shown herewith for the different positions shown on the diagram, and it can be seen that at the start the 2,500 lbs. initial compression of the spring exerts a resistance of 2,840 lbs. against the follower plate, or a leverage of 1.14 to 1, while in the final position a resistance of 20,000 lbs. of the spring exerts a resistance of 200,000 lbs., or a leverage of 10 to 1. It will be noticed, as indicated in the diagram, that the capacity of this gear is but 200,000 lbs. This, however, disregards friction, and actual tests have shown the gear to have a capacity of over 250,000 lbs. The curves given herewith show the resistance at the different points of movement both in compressing and releasing, and it will be seen that up to 1¼-in. movement of the coupler for a resistance of 30,000 lbs. the increase is very gradual, but that from beyond this point the resistance increases more and more rapidly until for the full movement of 2¼ ins. a resistance of 260,000 lbs. is indicated. The release line is almost vertical down to the 30,000-lb. point, from which it returns very rapidly. A release line of a similar shape is obtained from any intermediate load.



MCCORD DRAFT GEAR—CAM MOVEMENT.

At the final movement of the coupler head, a distance of about 2¼ ins., the spring has a movement of less than 4 ins., and at this point there is still ⅛ in. compression left in the spring, which prevents the possibility of the shock being delivered to a solid spring.


POSITION I. Leverage 1.14:1.
POSITION II. Leverage 1.2:1.
POSITION III. Leverage 1.6:1.
POSITION IV. Leverage 2.4:1
POSITION V. Leverage 4:1.
POSITION VI. Leverage 10:1.

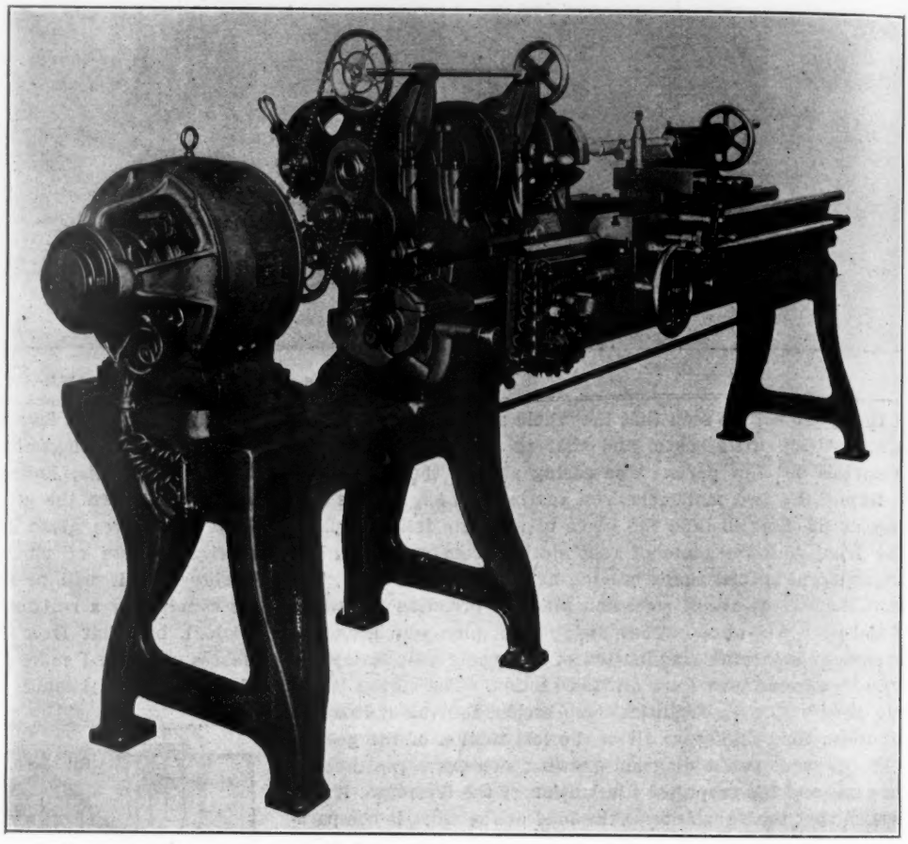
GRAPHICAL ILLUSTRATION OF LEVERAGES—MCCORD DRAFT GEAR.

INDUSTRIAL DEPARTMENT, ERIE R. R.—During the year ending June 30, 1905, there were seventy-six new manufacturing plants located along the lines of the Erie Railroad between Chicago and New York City, outside of any medium or large size city. The industrial department of this road has shown greater activity along this line than any other with which we are familiar.

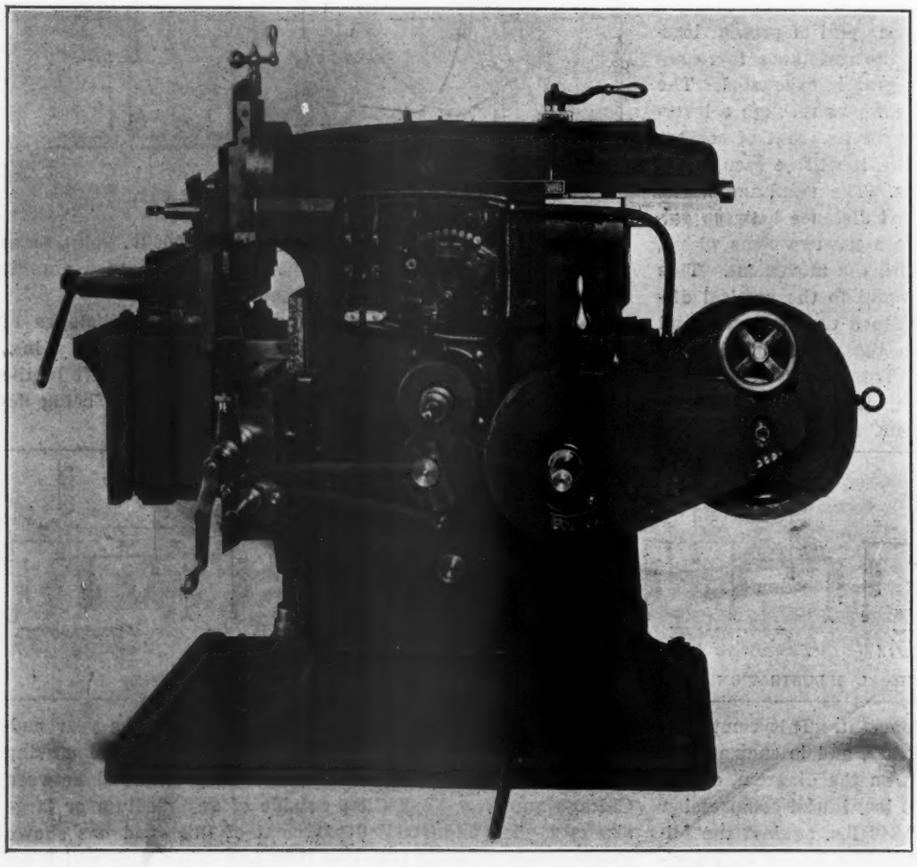
THE LINCOLN VARIABLE SPEED MOTOR.

The design and operation of the Lincoln variable speed motor differ so much from that of the ordinary type of motor that one is somewhat prepared for the rather strong claims, as to its advantages, made by the maker. The motors are regularly built for speed ranges as low as 2 to 1 and as high as 10 to 1, operating on an ordinary two-wire direct current circuit. It is claimed that the horse power is constant throughout the speed range and that the efficiency is exceptionally high. No controller is used but the changes of speed are made by withdrawing the armature from the influences of the field poles, thereby decreasing the field area and magnetic flux and increasing the air gap and resistance, thus increasing the speed. The change in speed is not made by jumps, as is the case when a controller is used, but is gradual. The motor runs equally well in either direction and is reversed in the usual way by reversing the field current. The motor is of the four pole shunt type, with the shunt field windings connected in series. The armature winding is similar to that ordinarily used in a shunt motor.

The armature is of a slightly conical shape, as shown in the drawing, thus giving a more rapid increase in the air gap and greater increase in speed for a given lateral adjustment than would be possible with a cylindrical-shaped armature. As may be seen from the illustration, the commutator end of the armature is supported by a thrust bearing carrying an annular ball bearing enclosed and protected from dirt to take both the thrust and the radial loads. This thrust bearing is actuated by a split lever having a central pull on the opposite sides of the thrust bearing, the movement of the lever being accomplished by means of a screw mechanism and hand wheel, a spring around the lever connecting rod being adjusted to balance the magnetic pull on the armature. The full range of speed may be obtained with a few revolutions of the hand wheel.



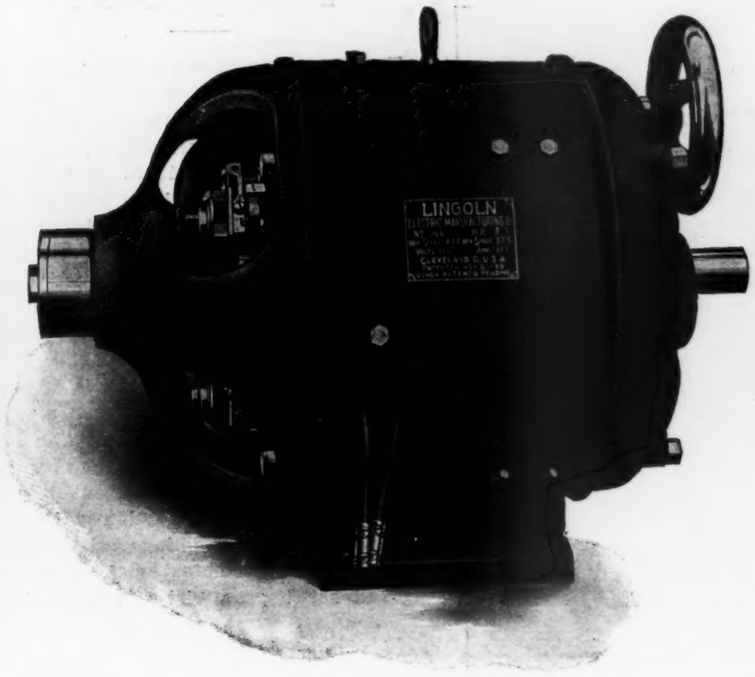
APPLICATION OF LINCOLN VARIABLE SPEED MOTOR TO LODGE & SHIPLEY LATHE.



APPLICATION OF LINCOLN MOTOR TO QUEEN CITY SHAPER.

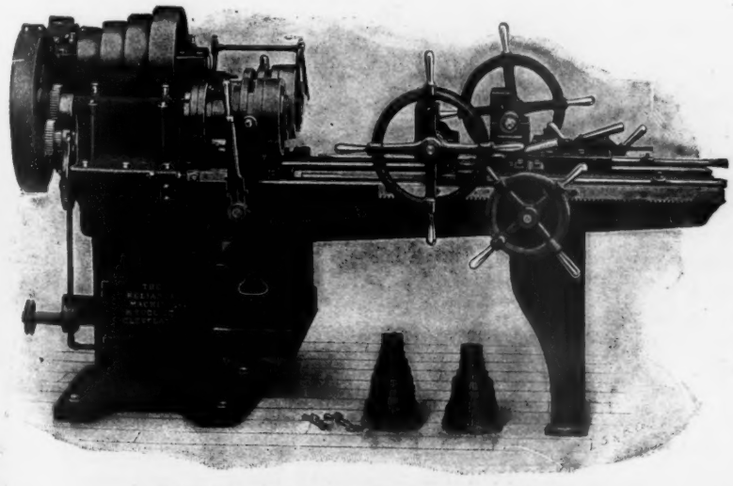
It is claimed that the motor may be overloaded as much as 100 per cent. at any speed without sparking, and that at lower speeds an even greater overload may be carried for short periods. It is stated that the efficiency at full load of a 5-h.p., 5 to 1 motor is from 86 per cent. at 300 r.p.m. to 75 per cent. at 1,500 r.p.m. It is also claimed that the motor speed is not affected by varying the load conditions.

One of the illustrations shows an application of the motor to one of the latest designs of



LINCOLN VARIABLE SPEED MOTOR.

shaper made by the Queen City Machine Tool Company, Cincinati, Ohio. The shaper has an improved feeding mechanism, the adjustment of which is made at the cross-rail. The drive is through a Morse chain protected by a casing as shown. The motor feet rest on pads on the side of the column, making the installation very compact. Another illustration shows an application to a Lodge & Shipley 16-in. lathe, the motor being supported by an extension of the frame which supports one end of the lathe bed. The hand wheel which controls the motor speed is placed above the head stock, convenient to the operator in his working position, and is connected to the motor by a shaft and link chain as shown. The motors on these two machines are both of an old experimental type, but correspond in size to the present 3½-h.p., 350 to 1,750 r.p.m. motor. As may be seen, the motor is quite small considering its capacity. The design of this motor has been patented by Mr. John C. Lincoln, and it is being manufactured by the Lincoln Manufacturing Company, Cleveland, Ohio.



RELIANCE 1½-IN. DOUBLE STAYBOLT CUTTER.

1 1-2 INCH DOUBLE STAYBOLT CUTTER.

The Reliance 1½-in. double staybolt cutter, shown in the illustration, is also built single, in 1½ and 2-in. sizes. The lead screw is located directly underneath the head stock and carriage, and is driven from the spindle by gearing. It is of large size with a coarse thread to insure long life. An automatic safety device disconnects the nut from the lead screw at the end of the forward travel of the carriage and thus prevents injury to the machine, if through carelessness of the operator the carriage should be forced against the die head.

The die head holds the dies rigidly in the working position and the locking mechanism releases freely. The locking mechanism consists of a positive hardened and ground lock bolt which snaps into a hardened and ground bushing when the barrel reaches the proper position. To further increase the efficiency of the dies the chasers fit into the die holders, thus preventing them from bearing on the die head. The holders, of tool steel hardened and ground, are of large proportions, thus preventing any tendency to clamp or bind, giving a large wearing surface and increasing the rigidity of the die head. The chasers are quickly and carefully adjusted by means of a screw. These machines, furnished for either belt or motor drive, are built in standard sizes from ¾ to 6 ins., inclusive. They are made by Foote, Burt & Company, Cleveland.

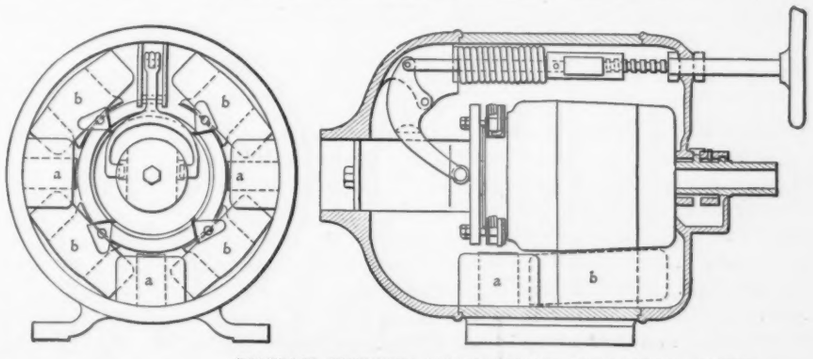
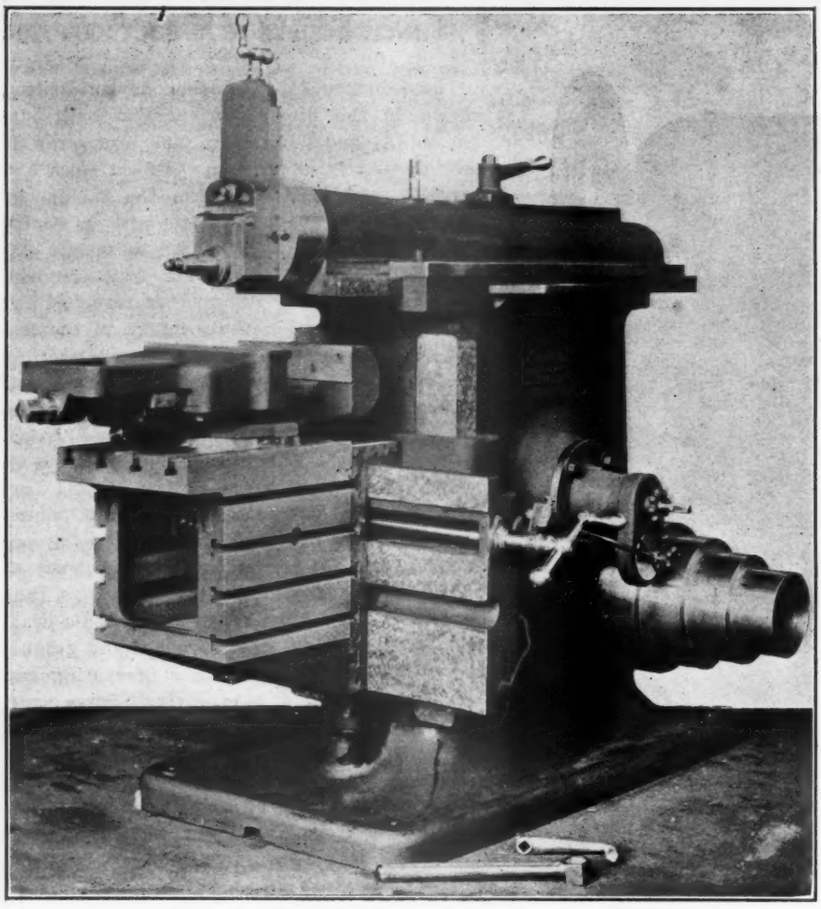


DIAGRAM SHOWING CONSTRUCTION OF LINCOLN MOTOR.

25 INCH HEAVY DUTY CRANK SHAPER.

The 25-in. heavy duty, back-geared crank shaper, illustrated herewith, is noteworthy because of the ease of manipulation, its great power and large capacity, and its simple and substantial construction. The column, of large proportions, is internally ribbed throughout, contains bored seats for all journal boxes, a flange for the crank gear sleeve, has a long bearing surface for the ram, and the ways for the cross rail extend from the top to the bottom of the column, thus making it very rigid. The base extends well out in the front, and is pan-shaped with no corners to prevent the oil and chips from being easily removed. The ram is long and wide, and is internally ribbed in such a way that it is strongest at that point which is subjected to the most severe strains. All adjustments may easily be made while the ram is in motion. It is 12 ins. wide, has a bearing in the column 37 ins. in length, and has a maximum stroke of 26½ ins. The tool head may be swiveled to any angle, and is securely locked by two bolts. The down-feed screw is provided with a micrometer collar reading to .001 in., and, if desired, may be fur-



SPRINGFIELD 25-IN. HEAVY DUTY CRANK SHAPER.

nished with an automatic down and angular feed.

The cross rail has a very long bearing on the column and is self-aligning, one of the ways on the column having an angular back face which the gib fits. By first tightening the screws in this gib, after an adjustment, the rail will always be square. The telescopic elevating screw is equipped with ball bearings. The table has large working surfaces on three sides. Instead of bolting it to the cross slide by means of planer bolts in the T slots, it has three large studs passing entirely through the top of the cross slide above the bearing on the cross rail. The cast iron is thus relieved of tensile strains and is placed under compression, which it is much better adapted to withstand. There are also two bolts at the bottom. No support is required under the box table, because of the enlargement of the ways on the column, the deeper cross rail, the method of fastening the table to the cross rail and the rigid design of the table. The table has a vertical adjustment of 15 ins. and a cross motion of 32 ins. The top surface of the table is 15¼ by 20 ins., and the depth of the cross rail is 21 ins.

The jaws of the vise are faced with steel, open 15 ins., and are 15 ins. wide and 3 ins. deep. The screw is entirely protected from chips and dirt. The crank gear journal has two diameters, thus reinforcing it at the point of greatest strain. It has large seats for the wrist block, heavily gibbed with provision for adjustment. The stroke arm is connected to the ram by means of a link in such a way as to provide space to allow a 4-in. shaft to pass entirely through the column for keyseating. The gears of the driving mechanism have wide faces and large pitches. The cone is designed for a 4-in. belt, is of large diameter and has four speeds, which, in connection with the back gears, gives eight speeds to the machine. The shafts are provided with a ring oiling device.

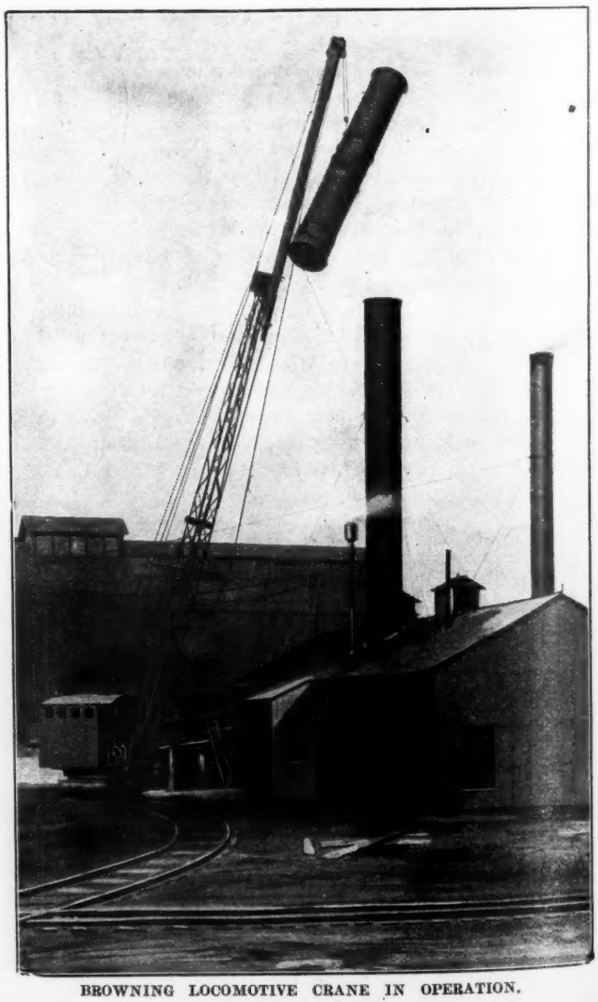
The net weight of this machine, which is made by the Springfield Machine Tool Company, of Springfield, Ohio, is 4,600 lbs.

UNIQUE OPERATION PERFORMED BY LOCOMOTIVE CRANE.

The illustration shows a unique operation recently performed by a No. 2 Browning locomotive crane. A 100-ft. steel smokestack was erected for a power station, the crane working at a radius of 25 ft. The top section of the stack weighed 4½ tons, and the photograph was taken as it was being lifted into place. It was necessary for the occasion to tie the heavy 40-ft. timber to the 65-ft. boom, leaving 10 ft. for lap.

The crane which was made by the Browning Engineering Company of Cleveland, Ohio, is operated by steam, and is designed for service on a standard gauge track. It has a tractive effort equal to that of an ordinary yard locomotive. These cranes are equipped either with or without a grab bucket or a hook block, and may be used for such work as handling coal or ashes, light wrecking, switching cars, heavy hauling and hoisting material of various kinds.

FERRIS WHEEL DESTROYED.—The Ferris Wheel which was constructed especially for the Midway at the Columbian Exposition, and was removed to St. Louis for the Louisiana Exposition, was destroyed by dynamite on May 11.



BROWNING LOCOMOTIVE CRANE IN OPERATION.

MASTER CAR BUILDERS' ASSOCIATION.

ABSTRACTS OF REPORTS.

BRAKE BEAMS.

Committee—A. E. Mitchell, chairman; R. B. Kendig, W. E. Sharp, W. F. M. Goss, G. W. Wildin.

Recognizing that the present standard requirements (adopted in 1889) for freight brake beams are inadequate for existing conditions of service, and that a very large percentage of the brake beams now used do not even approximate the M. C. B. specifications, this Association last year appointed your committee to investigate the subject and submit specifications and tests for brake beams for 60,000-lb., 80,000-lb. and 100,000-lb. capacity cars. Your committee found it necessary—

First—To determine the strength of the beams now on the market and ascertain their adaptability to the service required, which necessitated an investigation and test of the various beams which are now generally used. This investigation was undertaken for your committee by Purdue University as represented by Dean Goss, and was directed by Dr. W. K. Hatt, Professor of Applied Mechanics. Dr. Hatt was assisted by H. H. Scofield, Instructor of Applied Mechanics. [The brake beams were submitted to both the direct or pulling test and to a transverse test, and the results of these tests, as well as a description of the testing machine, are fully considered in appendices accompanying the report.]

Second—The duty of determining the proper location and dimensions of brake beams, to enable the committee to prepare specifications for beams of proper strengths, was delegated to a sub-committee, composed of Mr. R. B. Kendig, mechanical engineer of the L. S. & M. S. Railway, and a member of our committee; Mr. J. G. Platt, engineer of tests, Erie Railroad, and Mr. L. L. Bentley and his successor, Mr. J. N. Mowery, mechanical engineer, Lehigh Valley Railroad Company.

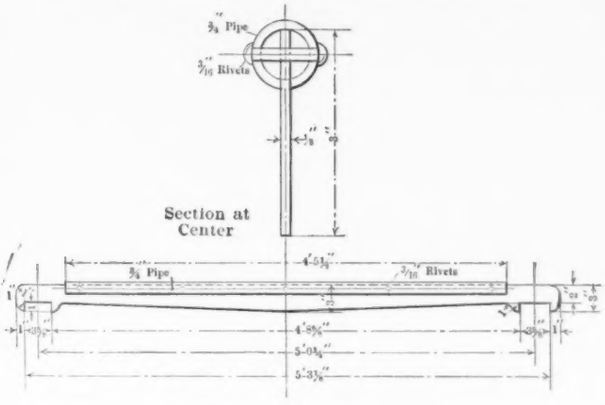


FIG. 3.—BRAKE BEAM GAUGE.

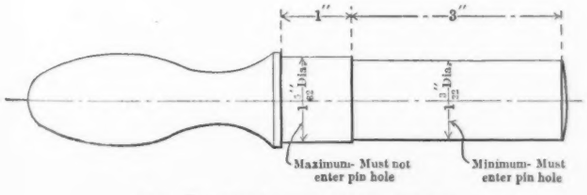


FIG. 6.—LEVER PIN HOLE GAUGE.

In order to carry out the tests at Purdue University, several beams of the various makes were taken from regular stock and donated to the committee by the following companies: Pennsylvania Railroad, Erie Railroad, L. S. & M. S. Railway, Lehigh Valley Railroad, Armour Car Lines, Pressed Steel Car Company, Buffalo Brake Beam Company, Chicago Railway Equipment Company, Gilbert P. Ritter.

PRESENT CONDITIONS.—A general review of the brake beam situation disclosed a deplorable state of affairs. It may seem a startling statement, but it is nevertheless true, that in many directions less attention is now being given to brake beams (the vital part of the foundation brake rigging) than twelve or fourteen years ago, notwithstanding markedly changed conditions, as well as greatly increased requirements of service. It also appears that in some cases *any* "metal brake beam" is interpreted as an acceptable beam.

INEFFICIENT BRAKE BEAMS.—Notwithstanding the increased requirements of to-day, due to both the weight of cars and speed of trains, and the fact that the present M. C. B. standard beams are not sufficiently strong for the service, a very large number of brake beams now being used do not even meet the specifications of 1889. The result is that such brake beams not only give inefficient service but soon fail.

Investigation shows that many new freight cars have been equipped with brake beams hung at variance with the M. C. B. standard height, also at variance with the height for which the brake beams were designed. This misapplication produces a torsional strain on the beams when the power is applied. This abuse, taken in connection with the overloading of weak brake beams, has resulted in a continually increasing number of distorted and broken beams, and has misled some to make the erroneous deduction that there is a "vertical" stress or load produced in service, which should be provided for.

Many roads are still applying "outside hung" brake beams, which we believe is radically wrong, as it is impossible to obtain satisfactory results with beams so hung. Outside hung beams are affected by the action of the bolster springs, curving of the trucks, sagging of the car body, etc., all of which prevent effective braking, and particularly under the varying conditions of loaded and empty cars. There is no argument in favor of such an arrangement, with the one exception, that they are more accessible.

A brake beam should be hung inside of the wheels to some *rigid* portion of the truck, so that it will always maintain the same relative position to the wheels; when so hung the beams are easier to maintain, and, not being exposed, are less liable to be struck by obstructions on the track (impromptu bumping posts, etc.). The first cost of the inside hung brake beam is less, they cost less to apply, and, most important of all, give more effective results in braking.

SUMMARY.

Your committee accordingly recommends for adoption as standard, two brake beams, which shall be known as beam No. 1, for use under cars having a light weight of 30,000 lbs. or less, and beam No. 2, which shall be used under cars having a light weight in excess of 30,000 lbs. Both beams shall conform to the following specifications:

SPECIFICATIONS.

1. All beams shall be 60¼ ins. in length from center to center of brake head, with an allowable variation of ¼ in. in each direction, and shall be proven by the gauge shown by Fig. 3, applied to the center and each end of the brake heads, which shall be the standard gauge for this purpose.

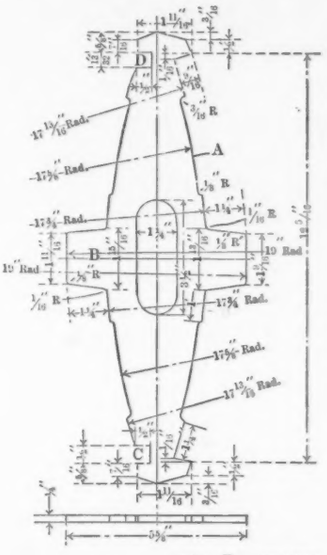

D
A
B
C
NOTE:-
Head must admit Side of Gauge marked-A-full depth and must fit Radius.
Distance between Center Lugs of Head must not be more than Width of B on Gauge.
Slots C & D are for Gauging Thickness of Metal between Face of Center Lugs and Key Slot.
C is Maximum and D is Minimum for this Thickness.

FIG. 5.—BRAKE HEAD GAUGE.

2. All brake heads shall conform to the M. C. B. standard dimensions, and shall be proven by the gauge shown by Fig. 5, which shall be the standard gauge for this purpose.

3. Attachments for safety hangers shall be 51 ins. from center to center.

4. The angle of the lever fulcrum shall be 40 deg. from the vertical.

5. The lever pinhole shall be 3 ins. in front of the top of the brake head lugs. The variation in either direction shall not exceed 1-16 in.

6. The lever pinhole shall not be less than 1 3-32 ins. in diameter, nor more than 1 5-32 in diameter, and shall be proven by the gauge shown by Fig. 6, which shall be the standard gauge for this purpose.

7. The maximum distance from the lever pinhole to the extreme back of brake beam should not exceed 9½ ins.

TEST.

8. For each 500 brake beams, or less, which pass inspection and are ready for shipment, one representative beam shall be taken at random, and subjected by the company manufacturing the beams, and in the presence of the railroad company's inspector, to the following test in a suitable machine:

The beams shall be equipped with suitable heads and shoes, and the shoes placed in contact with castings representing the tread of the wheel; when mounted in this manner the load shall be applied to the fulcrum in the normal line of pull. As a preliminary to the test, a load equal to the rated capacity shall be applied and released, after which observations for records shall be taken. Beam No. 1, under a load of 7,500 lbs., shall not deflect to exceed .0625 in.; beam No. 2, under a load of 15,000 lbs., shall not deflect to exceed .0625 in.

9. In case a beam shall fail in this test then a second beam shall be taken from the same lot and similarly tested. If the second beam stands the test, it shall be optional with the inspector whether he shall test a third beam or not. If he does not do so,

or if he does, and the third beam stands the test, the 500 beams, or less, shall be accepted as filling the requirements of this test.

10. Individual beams will not be accepted which (1) do not conform to standard dimensions, and (2) those that have physical defects. Any lot of 500 beams, or less, submitted for test, that fail to meet the prescribed test (Par. 8) will not be accepted.

RECOMMENDATIONS.

Your committee further recommends for adoption by the M. C. B. Association as recommended practice:

1. That all beams be inside hung.
2. That all beams be hung 13 ins. from the rail.
3. That brake hangers shall be attached to the brake head at the center, and just back of the central brake shoe lug.
4. That brake hangers shall be ⅞ in. in diameter.
5. That brake hangers should have an angle as nearly as possible to 90 deg. from a line drawn from the center of the brake shoe to the center of the axle, when the shoes are half worn.
6. Third suspension hangers should be used on all brake beams. They should be attached to flexible brackets, and should have the same angle and length as the brake hangers.
7. For safety hangers, chains should be used.
8. That, in order that these specifications may be generally observed, after September 1, 1910, all cars not equipped with brake beams built in accordance with these specifications, be subject to rejection in interchange on account of improper equipment.

Composite Design of Coupler.

Committee—F. W. Brazier, chairman; R. P. C. Sanderson, A. Stewart, T. S. Lloyd, C. E. Fuller, J. T. Chamberlain. Coupler manufacturers' representatives forming part of the committee—H. C. Buhoup, the Janney Coupler Company; Samuel Lewis Smith, National Malleable Castings Company; S. P. Bush, Buckeye Steel Castings Company; W. L. Jacoby, Latrobe Steel Coupler Company; F. P. Huntley, Gould Coupler Company.

The Special Committee appointed to confer with the Standing Committee on Tests of M. C. B. Couplers to consider the question of a composite design of coupler begs to submit the following report:

First it may be well to call attention to the duties of the Special Committee, which are outlined in the report of the Standing Committee on Tests of M. C. B. Couplers to the Master Car Builders' convention in June, 1905, which reads as follows: "That the Coupler Committee be empowered to act in conjunction with the specially appointed committee (in which should be included representatives of the manufacturers) to early decide upon a composite design of coupler which shall contain, as far as possible, the desirable features of the best couplers as now designed, and that all patent rights involved be waived and all manufacturers be permitted to manufacture the composite coupler as adopted."

The Special Committee is unanimous in its opinion on this subject, and you will note the instructions under which the committee was to work were very definite, concise and clear as to their meaning, leaving no latitude whatever, and after a thorough discussion of every phase of the subject that could be thought of, it was decided that the instructions could not be carried out and were impracticable at this time, and that the committee should report to the Standing Committee on Tests of M. C. B. Couplers and ask them for further instructions as to any further service said Special Committee could be in helping the Standing Committee along towards the general results which were aimed at by the Association in the formation of said committee.

It developed that of all the couplers currently bought and used in the United States to-day probably 90 per cent. were made by manufacturers who were represented on said committee.

It was agreed that only three or four of the couplers made (all of which were represented on said committee) complied reasonably well with the Interstate Commerce Safety Appliance Act; that none of said manufacturers were willing to give up their patent rights and surrender them to the Association. The reasons given by their side were principally twofold:

First—That we were asking them to surrender a considerable and valuable portion of their stock in trade, whereby they control the manufacture of the said couplers for their own benefit.

Second—That if the manufacture of said couplers were thrown open to any steel foundry or malleable iron foundry there would be no possible way in which the manufacture of inferior couplers, by any and every manufacturer, to the detriment of the standard manufacturers, could be prevented, the presence of which on the cars of the country would entail very great cost on the railroads, and be unfair to those who wished to purchase an efficient coupler complying with the specifications.

It was the consensus of opinion of the railroad representatives that it would be entirely unfair and not in accordance with business ethics to ask the manufacturers to surrender their rights without compensation, and that the Master Car Builders' Association is not a body which can properly acquire rights of this character and sell them or give them to manufacturers, without rendering itself liable to charges of unfair discrimination.

And further, that the adoption of such a standard as was proposed by the instructions would stop and impede progress in the coupler business, unless this work were undertaken by the Association, through the agency of the standing committee at the expense of the Association; whereas, now all reputable manufacturers spend considerable money yearly in developing and perfecting the couplers presented to railroad companies, thus meeting the increased demands of service without cost to the user.

It was agreed that it was a probable impossibility that any coupler could be designed which did not embody infringements on existing valid patents.

As the instructions required that the principal and best features of existing couplers shall be embodied in the design the committee was to work out, the position taken by the manufacturers blocked any possible action that could be taken by the committee.

As it seemed that the principal reason for the appointment of this committee was the trouble experienced by railroad companies to-day in keeping a stock of, and making repairs to, the very large number of patent couplers, and that this was the principal and real reason for the desired action, and as it was agreed that the existing couplers of many patterns could not be arbitrarily expunged from the cars, but would have to wear themselves out, it would be impossible, even if a standard coupler could be adopted to-day, to do more than gradually reduce the many patterns of couplers now in existence.

It was admitted and agreed that if we only had three or four kinds of couplers there would be no cause for complaint under this heading, and that other action would not be needed.

As it was shown, that for the reasons first mentioned the purchase of couplers had practically narrowed itself down to three or four makes, in this country, and the elimination of the many different patterns of couplers was already in progress, and that as the old couplers disappeared, renewals all being made by couplers of three or four makes, the principal source of annoyance now existing would be eliminated.

It was agreed that the second recommendation of the Standing Committee on Tests of M. C. B. Couplers, in its report to the M. C. B. Association at the convention held in June, 1905, which was "That the present policy of the Association be followed out; that is, that the gradual improvement of the M. C. B. standard coupler and the elimination of poorly designed and weak couplers be carried on as at present by making the requirements to be met by the M. C. B. coupler more and more rigid, thus compelling a higher degree of efficiency, and closely prescribing the limits for the future within which designers may work, while at the same time in no way preventing beneficial competition"—and which recommendation was not acted on by the convention—is far the best, and, in fact, the only plan which the Associaton can follow; that is, to have standard requirements for couplers and narrow these requirements down so as to limit the number of couplers which can successfully fulfil said requirements, and in this way drive out of the field inferior makes and multiplicity of patterns, leaving the field open for reasonable and honorable competition and development.

In concluding its report this committee strongly recommends that in the future no couplers be purchased by railroad companies unless they meet the requirements of the Master Car Builders' Association, and the recommendation of the Standing Committee on Tests of M. C. B. Couplers, as in this way the elimination of all couplers which do not fulfil the requirements would soon be effected.

Tests of Master Car Builders' Couplers.

Committee—R. N. Durborow, chairman; J. E. Buker, Theo. H. Curtis, F. H. Stark.

In view of the action taken by the Special Committee, your Coupler Committee would now recommend that the second proposition contained in the 1905 report of the Coupler Committee be adopted to govern the Standing Committee on Tests of M. C. B. Couplers for the ensuing year, which reads as follows: "That the present policy of the Association be followed out; that is, that the gradual improvement of the M. C. B. standard coupler and the elimination of poorly designed and weak couplers be carried on as at present, by making the requirements to be met by the M. C. B. coupler more and more rigid, thus compelling a higher degree of efficiency and closely prescribing the limits for the future within which designers may work, while at the same time in no way preventing beneficial competiton."

There are several slight inaccuracies and omissions in the M. C. B. drawings of standards and recommended practices in the Proceedings of 1905, for coupler and coupler yoke, to which your committee desires to draw attention as follows:

M. C. B. Sheet II. End view of coupler at bottom of sheet shows slotted instead of solid knuckle. As the solid knuckle has been adopted as standard, the drawing should be changed accordingly.

M. C. B. Sheet "B." Yoke for twin-spring gear and yoke for tandem-spring gear shows a dimension of 6⅛ ins. between legs of yoke. These yokes were designed for the 6½-in. coupler butt, and therefore this dimension should reach 6½ ins. The over-all dimension of 9 ins (over legs of yoke) is correct. and the 6⅛ ins. is a typographical error and should be corrected.

M. C. B. Sheet "B." There is no 5 by 5½ by 6½-in. butt shown on this sheet with 1 5-16-in. holes for the 1¼-in. rivets adopted as recommended practice. Inasmuch as the yokes are shown for this size butt, the coupler butt should be included on this sheet.

Prices for Repairs to Steel Cars.

Committee—T. H. Russum, chairman; R. F. McKenna, E. B. Gilbert, R. W. Burnett, G. N. Dow, W. F. Eberle, James Macbeth.

After very thoroughly going into this matter, the committee would recommend that Rule No. 106, page 43, of the 1905 Code of Rules, be changed to read as follows: "All rivets, 10 cents per rivet, which covers removal and replacing of rivets, including removing, fitting, punching or drilling holes when applying patches or splices, and replacing damaged parts, not to include straightening or repairing. Straightening or repairing parts removed from damaged car, 50 cents per 100 pounds. Straightening or repairing parts in place; also any parts that require straightening, repairing or renewing, not included on rivet basis, 20 cents per hour. Credit for scrap material removed from cars constructed of pressed steel or structural steel, ½ cent per pound."

AXLE LIMITS.

Committee—E. D. Nelson, chairman; J. H. Manning, C. D. Pettis.

The load carried on the axles is made up of the light weight of the car and the weight of the lading, from which would properly be deducted the weight of wheels and axles, as the weight of these is not transmitted to the journals. The standard axles are designed to carry stated loads, and not for cars of stated capacities. A comparatively light car body carried by axles of designated size is entitled to a larger weight of lading than a heavier car body on the same axles. It is undoubtedly true that when the capacity of a car is made the basis of axle diameters, regardless of the weight of the body, comparatively light cars are not carrying as much lading as they should; and, further, that axles are, in some cases, overloaded where the car body is excessive in weight and the marked capacity is not reduced accordingly.

Your committee, therefore, proposes that the present method of marking cars be changed, and that all cars ultimately should be stenciled with LIGHT WEIGHT and MAXIMUM WEIGHT. The former is, of course, the present light weight as used on all cars. The latter is the limiting weight that should be carried on four axles, depending, of course, on their diameters. It is not thought that shippers or others will be seriously inconvenienced by this change, and, on the contrary, the benefits to the railroads will be considerable.

The table entitled "Limits of Axles Based on Maximum Weight of Car" shows the present nominal capacity, the designation of each of the M. C. B. standard axles, and the load each was designed for. To this latter weight may be added the weight of wheels and axle itself, in order to arrive at the permissible weight per axle at the rail, as given in the fifth column. The permissible weight multiplied by 4 gives the total permissible weight at the rail for a car with 4 axles, and column 7 gives, in round numbers, the proposed MAXIMUM WEIGHT as recommended by your committee.

It will be noted that for cars of nominal capacity of 80,000 lbs., the only change is in the center of axle "C," which should be increased 1-16 of an inch. For 70,000-lb. capacity cars it is proposed to increase the limits for all diameters of the axle. For cars of 60,000, 50,000, 40,000 and 30,000 lbs. capacity, the limiting diameters for wheel seat and center would have to be increased. For cars of 20,000 lbs. capacity the limiting diameter of center only should be increased.

It should be understood, in the plan proposed, that the limiting diameters as now given in Rule 23 would hold good for all cars having CAPACITY marks, but that where the marking on cars is changed to show LIGHT WEIGHT and MAXIMUM WEIGHT the proposed limits, as shown in the table mentioned, would hold good. It is naturally assumed that cars having the older designs of axles will continue to have capacity marks up to the time when the axles under them may be changed to the standard axles, at which time the capacity marks would be removed and the MAXIMUM WEIGHT substituted.

Assuming that the plan above described meets with the approval of the Association, it would appear necessary to make modifications in both Rules 23 and 74, and the recommendation of your committee is that they should be changed to read as follows:

"RULE 74. When second-hand axles are applied under conditions which make them chargeable to the owners, the diameters of the wheel seats and center must not be less than, and the diameter of the journal must be ¼ in. greater than the limiting diameters given in Rule 23. If cars are marked with the word 'Capacity,' the first set of limits must be followed. If cars are marked 'Maximum Weight,' the second set of limits must be followed."

"RULE 23. Axles less than the following prescribed limits:

FOR CARS MARKED WITH "CAPACITY."

Capacity of Car.	Journal.	Wheel Seat.	Center.
100,000	5 ins.	6¾ ins.	5⅞ ins.
80,000	4½ ins.	6¼ ins.	5 5-16 ins.
70,000	4 ins.	5⅝ ins.	4⅞ ins.
60,000	3¾ ins.	5 ins.	4⅝ ins.
50,000	3½ ins.	4¾ ins.	4½ ins.
40,000	3¼ ins.	4⅝ ins.	3⅞ ins.
30,000	3 ins.	4¼ ins.	3½ ins.
20,000	2¾ ins.	4¼ ins.	3½ ins.

FOR CARS MARKED "MAXIMUM WEIGHT."

Maximum Weight.	Journal.	Wheel Seat.	Center.
161,000	5 ins.	6¾ ins.	5⅞ ins.
132,000	4½ ins.	6¼ ins.	5⅝ ins.
112,000	4¼ ins.	6 ins.	5¼ ins.
95,000	3¾ ins.	5½ ins.	4⅝ ins.
79,000	3½ ins.	5¼ ins.	4⅝ ins.
66,000	3¼ ins.	4⅞ ins.	4¼ ins.
58,000	3 ins.	4¾ ins.	4⅛ ins.
46,000	2¾ ins.	4¼ ins.	3¾ ins.

"All cars to have their light weight and capacity or their light weight and maximum weight stenciled on them."

TANK CARS.

Committee.—A. W. Gibbs, Chairman; C. M. Bloxham, Robert Gunn.

The Executive Committee, recognizing the fact that the present Recommended Practice of the Association is in some respects not adapted to the present state of the art, under date of February 12, 1906, reappointed the former committee with request that revised specifications be submitted for consideration as Recommended Practice.

The necessity for this has already been brought to the attention of railroads which have issued circulars on the subject of tank car interchange, and the reccomendations submitted are taken almost bodily from one of the railroad circulars, which circular was issued after joint conference of a number of roads issuing similar circulars.

The general specifications consider the trucks, brakes, safety appliances, attachment of the tank to the frame and the tests of the tank. Following this are the specifications for the application of safety valves and the requirements for old tank cars, having wooden underframe and for new tank cars. Mention is made of the fact that the Pennsylvania Railroad Company has patented a design which fullfils the requirements for new tank cars. After having this passed upon by the Eastern Railroad Association to make sure that such a car could be constructed without liability of patent infringement, the railroad company dedicated it to the use of the public. (AMERICAN ENGINEER, March, 1906, page 83.)

HIGH SPEED BRAKES.

Committee—F. M. Gilbert, chairman; C. B. Young, M. Dunn, J. J. Hennessey.

Your special committee, appointed to look into the question of our recommended practice for high speed foundation brake gear for passenger equipment cars, begs to report as follows: We have looked carefully into the matter and find that the gear for four-wheel trucks is satisfactory. There are, in our opinion, some small changes in the gear for six-wheel trucks which should be made before it is passed to M. C. B. standard. The objects to be accomplished by these changes are: Means for taking up by hand the slack, which accumulates from brake shoe and tire wear, more quickly and in smaller increments than is now possible. Your committee have in service an arrangement for accomplishing these results, but the information so far collected is not sufficient to warrant them in making definite recommendations covering the six-wheel truck. The committee would, therefore, respectfully ask for another year in which to complete its investigations.

LIMITS FOR AXLES BASED ON MAXIMUM WEIGHT OF CAR.

Nom. Cap. of Car. Lbs.	Axle. Designation.	Axle. Load. Lbs.	Weight of Axle and Wheels.	Permissible Weights per Axle at Rail.	Permissible Weights of Car and Lading at Rail.	Proposed Maximum Weight of Car and Lading at Rail.	Limiting Dimensions. Journal. Calculated.	Journal. Proposed.	Wheel Seat. Calculated.	Wheel Seat. Proposed.	Center. Calculated	Center. Proposed.
100,000	D	38,000	2,200	40,200	160,800	161,000	4.75	5	6.70	6¾	5.73	5⅞
80,000	C	31,000	1,925	32,925	131,700	132,000	4.32	4½	6.21	6¼	5.32	5⅝
70,000	C	26,000	1,925	27,925	111,700	112,000	4.15	4¼	5.89	6	5.03	5¼
60,000	B	22,000	1,675	23,675	94,700	95,000	3.71	3¾	5.48	5½	4.67	4¾
50,000	B	18,000	1,675	19,675	78,700	79,000	3.43	3½	5.22	5¼	4.51	4⅝
40,000	A	15,000	1,450	16,450	65,800	66,000	3.10	3¼	4.80	4⅞	4.09	4¼
30,000	A	13,000	1,450	14,450	57,800	58,000	2.97	3	4.58	4¾	3.90	4⅛
20,000	A	10,000	1,450	11,450	45,800	46,000	2.72	2¾	4.19	4¼	3.57	3¾

LOCATION OF TEMPORARY STAKE POCKETS.

Committee—A. Kearney, chairman; C. E. Fuller, A. Stewart, F. H. Clark, T. H. Curtis, J. S. Lentz, W. F. Keisel, Jr., L. H. Turner.

Your committee had scarcely hoped to be able to recommend a standard location for temporary stake pockets or even a location for a recommended practice; but, through the kindness of some of the pipe manufacturers who have manifested a particular interest in this work, have been able to secure a suggestion that would seem to at least satisfy that class of traffic, and incidentally would accommodate lumber shipments except loads handled on twin and triple cars, where it is required they be spaced, from center to center, not less than 2 ft. nor more than 3 ft. 6 ins., as referred to in Rule 48. The latter, however, is somewhat special, and refers to a shipment usually handled on flat cars, where the stake pockets are but seldom in excess of that measurement.

The cut (not reproduced) shows the longitudinal spacing for temporary side stake pockets, which are spaced 5 ft. center to center.

LOCATION OF SIDE AND END LADDERS ON BOX AND STOCK CARS.

Committee—W. E. Fowler, chairman; Joseph E. Buker, F. H. Clark, T. H. Curtis, W. R. McKeen.

We believe it is the general practice to locate the roof grab irons parallel to the side or end of the car on which the ladder may be placed, and are of the opinion that this roof grab iron is a sufficient indication as to the location of the ladder. We recommend that the Committee on Standards be instructed to modify the M. C. B. sheets and rules covering the location of grab irons to *show* the roof grab irons parallel to the side or end of the car on which the ladders are located, these grab irons to be placed between the limits of 12 or 15 ins. from the edge of the car.

(Additional Reports will appear next month.)

MASTER MECHANICS' ASSOCIATION.

ABSTRACTS OF PAPERS AND REPORTS.

Classification of Locomotive Repairs.

Committee—H. H. Vaughan, chairman; A. E. Mitchell, R. Quayle, D. Van Alstyne.

Your committee appointed to recommend a uniform system of classification of locomotive repairs considers this subject to properly comprise the following three separate questions:

1. A classification distinguishing between those engines which are in service and those which are under repair.

2. A classification distinguishing between those engines which are under running repairs and those which are under shop repairs.

3. A classification distinguishing between the various classes of shop repairs.

The distinction between engines in service and those under repair was, some years ago, very generally made by considering all engines in service which were not under or waiting repairs at a main shop or undergoing light overhauling at a roundhouse, and this practice, which is in many ways satisfactory, is still in force on many roads. With the increasing demands on an operating officer for obtaining the maximum service from the power assigned to him, it has become customary to establish some limit to discriminate between those engines from which he should be expected to obtain service, and those which, although not actually shopped, are held at the roundhouse for a sufficiently long time to make it unreasonable to include them in calculating the average daily mileage. As it is recognized that engines must receive small repairs from time to time, it is evidently simply a matter of agreement as to where the prescribed line should be drawn, but in view of the comparisons that are frequently made between one road and another as to the percentage of their power that is available for service, a uniform definition of this limit is important if such comparisons are to be of any value.

The distinction between running and shop repairs is at present largely a question of individual preference. Several roads have, however, already arranged their locomotive performance sheets to show the costs of these two divisions separately, and as this is of considerable importance in statements attempting any accurate comparison, it would be of indubitable advantage if uniformity could be secured.

The distinction between the various classes of shop repairs is made for two purposes: first to indicate in a general way the nature and extent of the repairs made to an engine, and, secondly, to allow of a rough measure being obtained of the output of a repair shop. In neither of these cases is a close definition possible without more complication than is either practicable or desirable. The detail repairs vary to such an extent on engines between which differences cannot be specified in any classification having a reasonable number of headings that, for the purpose of accurate comparison, either of one shop with itself, or of the various shops on a system, the costs or times required for specific operations must be dealt with, and not those of the accumulation of a number of those operations which may not correspond within wide limits even on engines which, as closely as possible, would be said to receive the same class of repairs. There would thus be but little advantage in the use of a uniform classification of shop repairs, and the object of this report is consequently to discuss the various systems employed and point out their respective advantages.

To obtain information as to the practice existing in the above respects, a letter of inquiry was issued, replies to which are tabulated below:

Name of Road.	Limit distinguishing between engines in service and those under repairs.	Limit distinguishing between running and shop repairs. Tires not turned.
Atchison, Topeka & Santa Fe.	24 hrs. from arrival...	$50.00
Atlantic Coast Line.....	When wanted for run..	
Baltimore & Ohio.....	If held for any repairs.	$25.00
Buffalo, Rochester & Pittsb..	24 hrs. from arrival..	Wk. done in r'dh.
Canadian Pacific.....	24 hrs. from arrival..	$100.00 labor.
Canadian Northern.....	24 hrs. from arrival..	Not out of ser'e.
Central Railroad of N. J.....		
Chesapeake & Ohio.....	12 hrs. from arrival...	$300.00.
Chicago & Alton.....	24 hrs. from time arr'd.	$50.00.
Chicago & North-Western....	Not ready when wanted.	Roundh'se work?
Chicago, Burlington & Quincy.	Shop repairs.....	$250.00.
Chicago, Milw'kee & St. Paul.	24 hrs. from time arr'd.	Tir's, flu's or $200
Delaware & Hudson.....	24 hrs. from arrival..	$100.00.
Denver & Rio Grande.....	24 hrs. from arrival..	
Duluth, So. Shore & Atlantic..	24 hrs. from arrival..	None.
Grand Rapids & Indiana.....	Shop repairs.....	Tires or $10.00.
Illinois Central	Five days.....	$100.00.
Lake Shore & Mich. South'n..	4 days from arrival..	R'd'e class of wk.
Mexican Central.....	24 hrs. after arrival..	None.
Minneapolis & St. Louis.....	Not ready when wanted.	Roundh'se work.
Northern Pacific.....	24 hrs. from arrival..	$400.00.
New York, Ontario & West'n.	24 hrs. from arrival..	By money value.
Pennsylvania Lines West.....	24 hrs. from arrival..	$10.00.
Seaboard Air Line.....	24 hrs. from 7 A. M...	Not out of ser'e.
Southern Pacific.....	Held for rep'rs o'er $75.	$75.00.
Union Pacific.....	Held for rep'rs o'er $75.	$75.00.

I.

The committee recommends that engines should be considered as under repairs if not ready for service within twenty-four hours of their time of arrival at the roundhouse, or in the case of engines assigned to regular runs or in helper or switching service, if not ready for their run.

II.

A classification distinguishing between those engines which are under running repairs and those which are under shop repair.

The table shows very little agreement with reference to the distinction between running and shop repairs, and illustrates, what has previously been mentioned, that this is very largely a question of individual preference. In its broadest sense the division should be made by terming those repairs which are incidental to the maintenance of an engine in service and the amount of which is approximately proportional to the miles run by the engine, running repairs, and those in which a number of the parts of an engine are repaired or renewed to place it in condition for making a further number of miles, shop repairs. The amount of the shop repairs is evidently independent of the miles run in the month during which they occur, and its nature is that of an occasional as against a continual maintenance charge. A further condition must also be observed, that repairs of sufficient magnitude to be individually worth analysis should be considered shop repairs, as running repairs are very generally reported as a total monthly sum and no record kept of the cost of each shopping. On some roads this represents simply the difference between work done in the shop and in the roundhouse, while on others, where main shops are conveniently situated, it is quite usual to do repairs in them that are essentially running repairs, while in many cases, also, work of considerable magnitude is handled in the roundhouse; and to obtain uniformity some more definite limit than this must be established.

While this cannot be done with any logical accuracy, it is evidently in accordance with general practice to define it by the amount of money expended, and, if accounts are to show the cost of running and shop repairs separately, it is preferable that this represent the estimated rather than the actual cost.

In that case, when an engine is reported under repairs it is at the same time reported as under shop or running repairs, as the judgment of the foreman may determine, and the cost of the work booked accordingly. On this account there is also an advantage in basing the limit on the value of the labor expended, in place of on the total of material and labor, as it can in general be more closely estimated, and in repairs of this nature the cost of the labor is also a better indication of the extent of the repairs effected than is the total cost of material and labor. On this basis your committee considers it may be stated that repairs on which the labor is under $50 might safely be described as running repairs, while those on which it is over $100 would certainly be of sufficient importance to warrant them being individually reported and considered as shop repairs; and in view of the constantly increasing size of locomotives and the desirability of avoiding unnecessary complication it would select the higher limit as preferable.

Running repairs are those, whether made in shop or roundhouse, in which the estimated labor does not exceed $100.

III.

A classification distinguishing between the various classes of shop repairs.

The system in use for classifying shop repairs varies with each road or group of roads reporting. What may be termed the money system is in extended use, in which the class of repairs is graduated by their cost, varying frequently with the size of the engine. It is difficult to see what object is served by a classification of this nature, as it affords no information as to the work done on the engine, and the shop output can only be measured by the total sum expended. If, for instance, on any class of engine a No. 2 repair is defined as one costing between $1,500 and $1,000, while a No. 3 costs between $1,000 and $500, and one shop is doing the same class of work for $900 that another does for $1,100, the first shop would only receive credit for a No. 3 repair, while the other would be credited with a No. 2, so that evidently this method is of no use as a measure of output. It may be objected that no classification can be of any use, but this would appear to be about the only argument justifying a classification by cost.

The simplest, and what may be termed the most primitive, method is that where repairs are classified as light, general and heavy, but it is evident that such a classification does not afford specific information with regard to the work done, whether tires were turned, tubes reset, and the extent to which the machinery and boiler was repaired. It has therefore been developed by increasing the number of classes up to six or eight, each class defining such combinations of repairs as are found to usually accompany each other. A good example of this system, which may be termed the numerical, and which is representative of that used by many roads, is herewith presented:

Class 1 repairs contemplate a new boiler, and all necessary work in addition thereto.

Class 2 repairs cover new firebox, tires turned or renewed if necessary, and all necessary machinery repairs.

Class 3 repairs; all flues reset or renewed, tires turned or renewed, and necessary machinery repairs.

Class 4 repairs; flues reset or renewed, either full or part set, and necessary repairs to machinery.

Class 4a repairs; one-third or less flues reset or renewed, tires turned or renewed, and necessary machinery repairs.

Class 5 repairs; tires turned or renewed, and such machinery repairs as are necessary.

Class 5a repairs; any repairs which are not included in the above classes, except accident repairs. Class 5a repairs is generally machinery repairs of which the labor cost amounts to more than $10.

Class 6 repairs; repairs which are due to accident and for which the motive power is not responsible.

This type of classification has the objection that in spite of the number of classes of repairs, the information obtained is quite indefinite. The classes of repairs Nos. 1, 2, 3, 4 and 5, inclusive, vary simply according to the amount of boiler work performed, and the information obtained is that tires have been turned and machinery repaired with the following boiler work:

Class 1, new boiler.
Class 2, all tubes reset.
Class 3, new firebox.
Class 4, one-third or less tubes reset.
Class 5, no tubes reset.

No distinction is thus made between an engine having side sheets and front tube sheet removed and one in which no firebox work is done, and it would certainly appear that such differences should be recognized in any classification for the purpose of obtaining definite information. A further objection is that Classes 4 and 5 are the only ones in which any distinction is made as to the extent of the machinery repairs, as in those classes tubes are not turned or renewed; but otherwise no information is obtained as to whether machinery repairs are light or heavy, and in view of the common practice of giving engines intermediate repairs to machinery, it would certainly be an advantage to indicate what was done. It would, however, on this system introduce at least three additional classes, as Classes 3, 4 and 5 repairs might each include light or heavy machinery repairs. If this were done there would then be ten classes of repairs, without including those required if the firebox work was more closely specified, and the tabulation of those to present any intelligent comparison of shop output would certainly be exceedingly difficult. While, no doubt, the system has worked exceedingly well, especially on roads where the conditions were more or less uniform and the repairs were very generally capable of classification under two or three numbers, it has evidently the fault of specifying by a number each combination of repairs to boilers and machinery, and necessarily becomes complicated if the combinations vary from time to time.

An analysis of this system shows that the various elements entering into the above classification are as follows:

1. New boiler.
2. New firebox.
3. All flues reset.
4. One-third or less flues reset.
5. No tubes reset.
6. Machinery repairs with tires turned.
7. Machinery repairs without tires turned.

These various elements have been combined in seven different ways covering those most likely to occur in service, but from the above discussion other elements might with advantage be introduced as follows:

8. One firebox sheet renewed.
9. Two firebox sheets renewed.
10. Three firebox sheets renewed.
11. Four firebox sheets renewed.
12. Tires turned with general repairs to machinery.
13. Tires turned with light repairs to machinery.

When this is done the number of combinations that may occur becomes far more numerous, as either 8, 9, 10 or 11 may occur with 3, and with either 12 or 13 into which 6 has been divided, and as information as to these elements is certainly required to define the repairs received by an engine, the numerical system practically becomes unwieldy, and it has on several roads been developed into the divisional system in which a combination of letters or numbers is used to indicate the repairs received.

An inspection of the various elements enumerated above shows that they may be divided into three divisions—machinery, tubes and firebox, as follows:

Machinery repairs:
1. General repairs to machinery with tire turning.
2. Light repairs to machinery with tire turning.
3. Light repairs to machinery without tire turning.

Flue repairs:
1. All reset.
2. Part reset.

Firebox repairs:
1. One sheet.
2. Two sheets.
3. Three sheets.
4. Four sheets.
5. Five sheets.

On the divisional system, in place of specifying certain combinations of these elements and assigning a number to each combination, the class of machinery tubes and firebox repairs effected are mentioned separately, as, for instance, an engine having a general repair to machinery, all tubes reset and two firebox sheets renewed is said to have a No. 1 machinery, No. 1 tube and No. 2 firebox repair. This may be abbreviated to M. 1, T. 1, F. 2, or more simply to 1-1-2, providing zero is understood to mean no repairs, and the class of repairs received by an engine within the limits of definition included in the list of elements is thus concisely and clearly determined. It is evident that this system does not attempt any closer definition of the class of repairs received than does the numerical, but it states them in a more convenient way, and also enables reports to be more closely arranged.

The heading required for reporting engines receiving repairs at any station is as follows:

Engine Number.	Class of Repairs.			Other Information as Required.
	M.	T.	F.	
1,000	1	1	2	

The statement of engines turned out at various points during any period is as follows:

Shop.	Machinery.			Tubes.		No. of Firebox Sheets.	Other information as to days or under repairs, running repairs, etc.
	1	2	3	1	2		
New York	17	12	8	22	1[illegible]	12	

It will be noticed that the report of engines receiving repairs defines the work done to each engine, while the statement showing the repairs made at each shop does not connect the repairs made to each engine, but simply summarizes the amount of work turned out.

This summary does, however, show the number of general, intermediate and light machinery repairs each period, the number of tubes reset or part set, and the total number of firebox sheets applied, and thus affords as clear a statement of shop output as can be obtained without going into greater detail, and also, when totalled for all shops in a district, enables a fairly close estimate to be made, as to whether the required amount of shop work on the system is being obtained.

It may be objected to, and with good reason, that a classification of this nature does not define the repairs received with sufficient accuracy to allow of fair comparisons to be drawn; as, for instance, one engine receiving No. 1 machinery repairs may require a new driving axle, a new pair of cylinders and frame taken down, while another receiving the same class of repairs may not require any of those especial items, or that a firebox sheet may mean a flue sheet on one engine and a side sheet on another; but the only answer can be that any system going into such details would become so complicated as to defeat its object, and that such information must be obtained from the work report and not from the statement of shop repairs.

The latter is and should be a general summary, and the explanation of the amount of work performed can safely be left to the man whose output is not fairly allowed for.

One important point to consider is the allowance that should be made for the size of the engines repaired, as it is obviously true that the large and heavy locomotives now being used cannot be either repaired or maintained for the same amount as smaller engines. From the point of view of the shop alone probably the best comparative unit for this purpose would be the weight of the engine, as this determines the amount of material it is composed of, and is consequently a measure of its cost and also of the cost of the labor necessary to repair it. There are, however, many reasons for using a unit for repairs which is also to be used for general purposes, and your committee feels that, while not strictly included in this subject, reference may be made to the tractive power mile introduced by Mr. A. A. Goodchild, when auditor of statistics on the Canadian Pacific Railway, which has many advantageous features. On that road the tractive power is expressed in the usual way as a percentage, an engine shown as 100 per cent. having a drawbar pull of 20,000 lbs. calculated at 85 per cent. of the boiler pressure. An engine having a tractive power of 30,000 lbs. is shown as making 1.5 100 per cent. miles for each mile it runs, and the cost of repairs is calculated both for the locomotive mile and the 100 per cent. locomotive mile. This unit is also used in a number of other ways, but the above example will illustrate its principle. The test of two or more units is their approximation to the truth, and in comparing those suggested for the comparison of locomotive repairs, the miles, the engine ton-mile and the tractive power, or, as it may be called, the 100 per cent. mile, the mile may be first eliminated, since with engines varying in weight in the ratio of three to one it is evidently inaccurate. Considering the 100 per cent. mile as against the engine ton-mile, if two engines weigh the same, but one is a consolidation, the other a ten-wheeler, the consolidation will cost more to repair. On the engine ton-mile basis the allowance would be the same, on the 100 per cent. mile basis the consolidation will obtain a greater allowance, which will to a certain extent compensate for its greater cost of upkeep. If, again, two engines of equal weight are compared, one passenger and one freight, the freight engine will cost the larger sum per mile. On the 100 per cent. mile basis this is partly compensated for by the increased tractive power, and this unit may therefore be said to be the closer. Your committee does not consider it necessary to define the tractive power which constitutes 100 per cent., as that is unimportant, provided it is known and allowed for; but in view of the merits of the tractive power or 100 per cent. mile as a unit, it would recommend that the same unit be used in allowing for the output of a shop. By including this factor the statement of engines receiving repairs at any point in place of showing the number of engines actually receiving No. 1, 2 and 3 machinery repairs, etc., would show the equivalent number of 100 per cent. engines receiving such repairs, and a 50 per cent. engine counting as 0.5 and a 150 per cent. engine as 1.5 100 per cent. engines turned out, and so on, and your committee then considers that the output of the various shops would be measured as closely as is practicable without objectionable complication.

Locomotive Lubrication.

Committee—E. D. Bronner, chairman; R. F. Kilpatrick, C. Kyle, R. D. Smith.

This subject is of vital importance to every railroad company, and, as the information at hand does not warrant us to draw definite conclusions in all cases, the report should be considered as a preliminary one.

The committee, in investigating the subject, divided the work, so that each member could devote his time to one phase of the subject. Consequently the report represents the combined effort of the committee.

A PROPER LUBRICANT FOR HIGH STEAM PRESSURE AND SUPERHEATED STEAM.

For locomotives with steam pressure as high as 225 lbs., or those using superheated steam, the temperature of which is as high as 600 deg. F., the ordinary valve oil has been found by experience to be quite satisfactory. The problem is to deliver the oil in proper quantities to the place where needed.

ECONOMY IN INTERNAL LUBRICATION.

In order that the engine parts may perform their work properly and without undue wear or heating, lubrication here should not be stinted. Dry valves and cylinders mean rapid wear of the surfaces of contact in the steam chest and cylinders, besides excessive trouble with the valve motion parts. An attempt to get even at the minimum of oil used for internal lubrication is apt to result in hot or slipped eccentrics, and broken eccentrics, eccentric straps, links, transmission bars, rockers, valve stems and connection pins, in addition to the trouble just mentioned. Aside from increased machine friction, the performance of the engine is affected. Hard running valves cause a derangement in steam distribution; and worn packing in valve chambers, cylinders, or at rods, causes a loss due to leakage.

With the slide valve locomotives there is not so much danger of these troubles becoming excessive, because the jar of the reverse lever is such an annoyance to the engineer that he at once exerts his energy to seeing that the valves are properly lubricated.

With piston valve locomotives the internal lubrication may be much below that required without any indication from the reverse lever. Under these conditions the annoyance comes to the man responsible for maintaining the locomotives, and the cause of the trouble may have been operating for a long time before being discovered, or indeed may be lost sight of altogether. In other words, with slide valve engines, when the oil allowance is just sufficient or only a little in excess of what is needed, the engineer is more apt to keep the valves supplied with enough oil to prevent hard service to the machine; while, with the piston valve engines he is not so able to tell that the valves need oil, and no one knows that the parts have been running too dry until trouble comes through heated bearings, or worn and broken parts.

Summarizing: For internal lubrication seventy miles per pint for large freight locomotives and eighty miles per pint for large passenger locomotives, would seem to be the amount needed to lubricate properly. The amount to each class depending upon the speed at which the locomotive is running. In bad water districts the oil allowance should be increased about 25 per cent.

ECONOMY IN EXTERNAL LUBRICATION.

The use of grease on crank pins and driving axles seems to offer the best solution of how to decrease the cost of external lubrication, and at the same time secure the better results.

Information gleaned from four years' experience with 203 locomotives, fully equipped for grease lubrication during all or part of that time, would indicate that to lubricate pins and driving axles with grease instead of oil reduces the cost of external lubrication. Along with the reduction in cost there has been a decided decrease in engine failures due to hot bearings. Journals lubricated with grease are less apt to be cut, and cut journals require turning. Hence grease lubrication increases the mileage between turning of axles and pins. The action of a grease lubrication system applied to driving boxes is practically automatic. On this account its action is independent of whim or neglect of the engineer, and it applies lubricant at the time it is needed in approximately the right quantities. Some objection has been raised to the use of grease as a lubricant on account of increased machine friction. Within the experience of your committee it has never been found necessary to reduce the tonnage rating of a locomotive on account of changing from oil to grease. It would seem, therefore, the reasonable conclusion that this effect is slight, and in view of the material advantages coming from the use of grease, need not be considered.

As a general résumé of this phase of the subject, grease as a lubricant on locomotives gives results about as follows:

(a) Reduces engine failures due to heated journals and pins.
(b) Reduces cost of lubrication.
(c) Reduces cost of labor incident to inspection, cleaning and renewals of lubrication packing.
(d) Reduces delays incident to oiling.
(e) Reduces cut journals incident to oil lubrication.
(f) Possibly produces a slight increase in machine friction.

THE CONSIDERATION OF STANDARD FITTINGS FOR LUBRICATORS.

To facilitate the use of different lubricators on the same railroad we would propose a standard as to relative location of holding arm shoulder and oil and steam connection joint faces; and a system of standard fittings and joints for all connections.

LUBRICATORS VS. PUMPS.

Data collected from twelve different systems would seem to indicate that pump lubricators of whatever description are still in a state of imperfection, and that quite as good results have been obtained by using the ordinary sight feed lubricator, even on superheated locomotives.

SUPERHEATED STEAM ON AMERICAN LOCOMOTIVES.

INDIVIDUAL PAPER, BY MR. F. J. COLE.

The theory of the superheater has been presented by Mr. H. H. Vaughan, in his paper before this Association last year. The general subject of superheating, as applied to locomotives, was admirably presented by Dr. W. F. M. Goss before the Franklin Institute in February, 1905, and published in the September journal of that body. In his paper on "Superheated Steam on the Canadian Pacific Railway," presented before the New York Railroad Club in April, 1906, Mr. H. H. Vaughan recorded the results of service experience with a very large number of superheaters on that road. No attempt will be made here to go over the ground so well covered by others.

At the present time it can be asserted confidently that the application of the superheater to American locomotives has come to stay. A sufficient time has now elapsed since its more extended application, which has taken place in the last three or four years, to justify this assertion. The locomotives so equipped have been distributed over a sufficiently wide area to include, generally, all sorts and conditions of service, so that the various kinds of fuel, water, local conditions, etc., necessary to consider in the successful working of locomotives, have been included in these trials.

While some discouraging conditions, such as the accumulation of iron slag on the outside ends of the superheater tubes, caused apparently by an excess of iron in certain grades of coal, have been met with in two or three instances, yet on the whole the consensus of opinion from various railroads confirms the statement that superheating, as applied to locomotive engines, is correct in principle and theory. The economies obtained in fuel and water are considerable, and superheating, generally, may be considered as a substantial improvement in the operation of locomotives under American conditions.

Following the practice abroad, force feed lubrication was at first considered necessary, and the principal makes of these lubricators, both foreign and domestic, were used in order to determine which kind was best adapted for the purpose. Experience has shown that the usual type of sight feed lubricators, with independent feeds to each inlet of the cylinders, give very good results and the valves and cylinders, on a number of superheater locomotives now running are successfully lubricated in this manner. Two lubricators are usually employed, with three feeds for each cylinder, two of the feeds going to the ends of the piston valves and one to the center and top of the cylinder barrel.

The temperature of saturated steam at 200 lbs. pressure is 387 deg., and with 150 deg. of superheat, the temperature of the steam will be 537 deg. It would appear that this is somewhat higher than the flashing point of the valve oil in regular use and it is probable that some of this is vaporized before the valves and metal surfaces are properly lubricated. This is offered as a possible explanation of the slight increase in oil consumption in lubricating valves and cylinders of locomotives equipped with superheaters.

The circulation of steam in the type of superheater which the American Locomotive Company first developed was produced by an internal circulating tube, commonly known as a Field tube. The boiler or fire tubes were 3 ins. O. D., the superheating tubes 1¾ ins. O. D. and the circulating tubes 1 1-16 ins. O. D. This style of superheater was the first one applied by the American Locomotive Company to a New York Central Atlantic type engine in June, 1904, and is illustrated in the AMERICAN ENGINEER of September, 1904, page 338. This superheater is still in service, and the locomotive to which it is applied is running fast express trains between Albany and New York.

A similar arrangement with the same size tubes was soon after applied to some Canadian Pacific consolidation locomotives. For a few subsequent applications the fire or boiler tubes were increased to 3½ ins., with a view of raising the temperature by increasing the area of the flow of the gases.

In the majority of cases the later forms of superheater applied by the American Locomotive Company have been of the return bend system, with boiler or fire tubes 5 inches O. D., and four superheating tubes 1¼ ins. O. D., 15-16 in. I. D., united in pairs at the firebox end with return bends. A much larger number of locomotives have been equipped with this later arrangement than with the original circulating tubes, and some sixty equipped in this manner are now in successful service. An average superheat temperature of 130 deg. has been usually obtained by this arrangement in passenger service. The temperature was taken at the steam chest by means of accurate instruments, and for this purpose high-grade thermometers with the bulbs immersed in tubes containing heavy oil were used.

With this degree of temperature substantial economies in fuel and water have been obtained. A later development of this style of superheater is shown in Fig. 1, in which the joints between the vertical headers and tee pipe are made by means of cast-iron ball-joint rings, each header having independent bolting, so that it may be put in place or removed without interfering in any way with the others. One advantage of this design is that in case any of the large boiler tubes require resetting at the front end, or renewing, it can be readily done by the removal of one section without interfering with the rest of the apparatus. The independent or sectional vertical headers are especially designed with this end in view. The tubes at the firebox end are connected together by return bends, funnel shaped, presenting the least possible obstruction for the accumulation of slag or cinders. For the ready removal of any foreign substance, it can be easily seen that a flue auger or cleaning rod may be used and the flues freed from accumulations to better advantage with this form than with an ordinary return bend. The design of this is shown in Fig. 2. The joints of the superheater pipes with vertical headers are made by the simple method of expanding by means of a roller in a similar manner to ordinary boiler tubes, the roller for this purpose being inserted in the hole in the front of the header, which is afterward closed with a screw plug with square end.

TESTING APPARATUS.—For the development of the latest design, a testing apparatus was constructed so that the efficiency of various forms of superheating tubes could be demonstrated. Briefly it consists of a 12-inch wrought-iron pipe 20 ft. 11 ins. long, closed at the ends with flanges and heads. In the center of these heads a single 5-inch O. D. pipe is expanded to represent one complete unit of the apparatus, as applied to a locomotive. At one end it is provided with a sheet-iron box to represent the smoke-box of a locomotive, and to contain the saturated and superheated steam headers. The 12-inch tube was filled with hot

water under pressure connected to a stationary boiler. At the other end a small oil burner, similar to those used in shop furnaces, was used. A tank mounted on a platform scale, containing oil, was connected by means of rubber hose and provided with air pressure for atomizing the oil. Thermometers were inserted at different points to measure the temperature. The saturated steam was kept at a uniform temperature and arranged to enter and discharge through diaphragms of uniform dimensions. A calorimeter was used for determining the amount of moisture in the steam and the test generally conducted so as to eliminate, as far as possible, all errors.

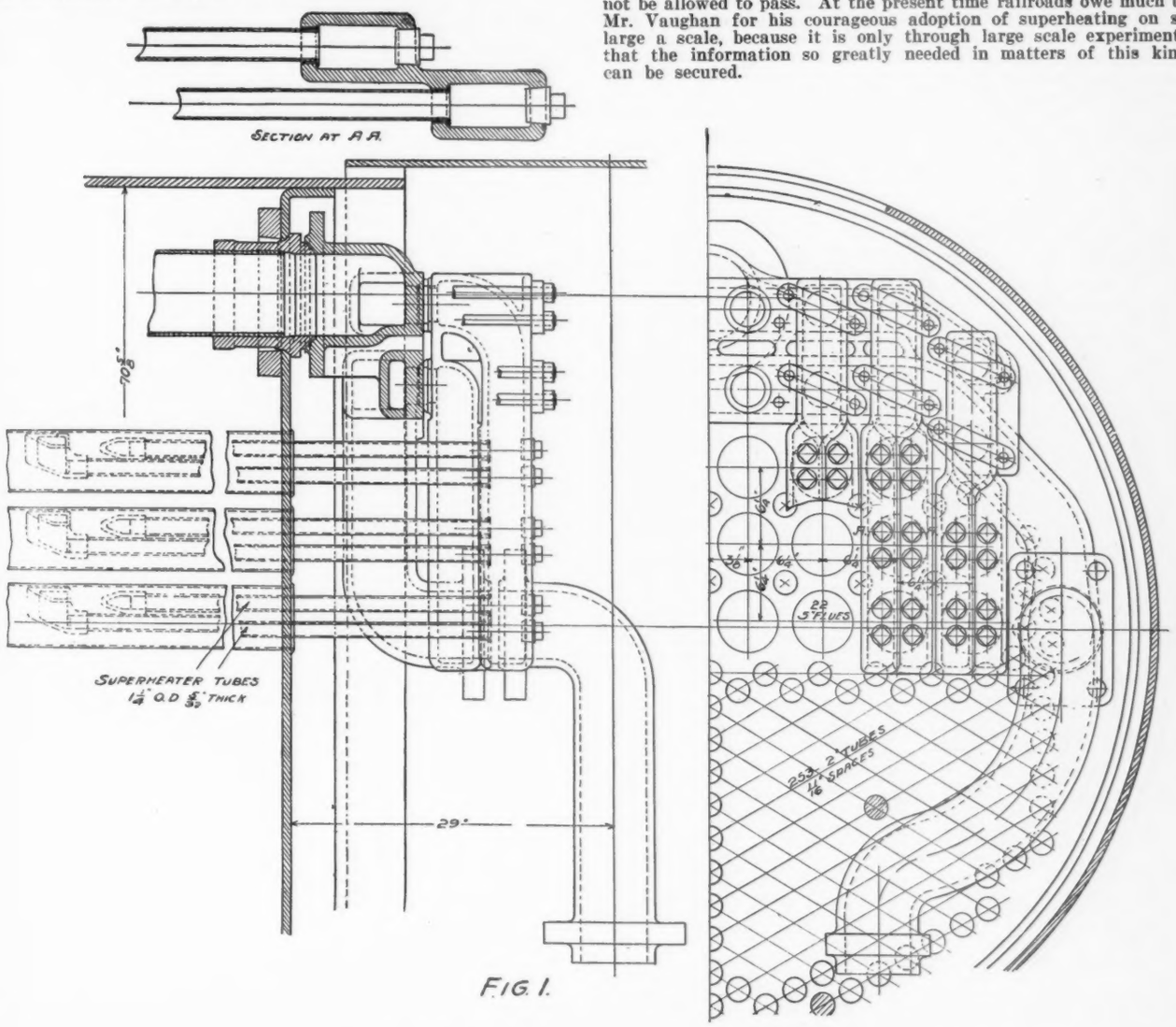


FIG. 1.

The amount of superheat obtained was measured by high-grade thermometers, with bulbs immersed in heavy oil, and the efficiency of the different systems determined by the number of B. T. Us. absorbed by the superheated steam. The original Schenectady superheater with the flow of saturated steam through the circulating tube and the superheated steam in the same direction as the flue gases, gave a figure of 39 to the basis of 100 for the results attained by the design shown in the illustrations. With the direction of the flow reversed, the figure obtained was 70, which would appear to indicate that a substantial gain is effected by causing the saturated steam to flow in a direction opposite to the flue gases.

On the other hand, under certain favorable conditions, in which the fuel causes no clogging up of the tubes, the original arrangement with 3-in. fire tubes has given very favorable results, an average temperature of between 105 deg. and 110 deg. at the steam chest being obtained, and the maximum temperature at times 25 deg. or 30 deg. in excess. In a test extending over many trips, carefully made to eliminate as many errors as possible, a fuel saving of 17 to 19 per cent. was effected.

A Prairie type passenger engine equipped with the later form of return bend superheater has been running on the L S. & M. S. Ry. in passenger service for several months, and while no accurate tests have been made, it is the opinion of the men in close touch with this engine that there is a saving in fuel and water of at least 15 per cent., and a substantial improvement in the running and operation of this engine. It is considered a very lively and fast engine, and is able to handle the heavy passenger trains with apparently greater ease than similar engines not so equipped.

On the Canadian Pacific Railway fifty-five ten-wheel freight engines have been equipped by the American Locomotive Company with a similar form of superheater, but some improvements have since been made in the joints and bolting. These are working well and showing economies at least equal to compounds.

Absolute perfection of detail is too much to expect in so short a time in the application of so radical a principle. Since the theory of a superheater was presented before this Association last year, facts from experience have become available which tend to confirm the opinion that future locomotive development is to include this principle.

This opportunity to comment upon the very satisfactory attitude of the Canadian Pacific Railway toward superheating must not be allowed to pass. At the present time railroads owe much to Mr. Vaughan for his courageous adoption of superheating on so large a scale, because it is only through large scale experiments that the information so greatly needed in matters of this kind can be secured.

At the present time superheaters are in service upon or being built for the following railroads:

Canadian Pacific	186
Chicago & North-Western	2
Chicago, Rock Island & Pacific	6
Lake Shore & Michigan Southern	2
Delaware, Lackawanna & Western	1
Chicago, St. Paul, Minneapolis & Omaha	3
Michigan Central	1
Boston & Maine	1
Northern Pacific	3
	205

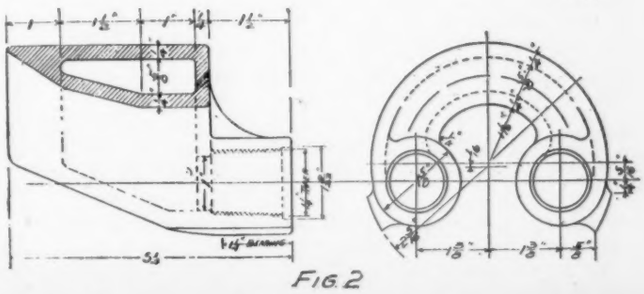


FIG. 2.

and while some reports are better than others, the resultant of all the trials justifies the statement that railroads are perfectly

safe in taking into consideration this feature for new power and for renewals of old power.

In connection with superheating it is possible to reduce boiler pressure without loss of power and in further experience this may become an important factor. Thus far superheaters have been applied to existing designs and the application has, in general, been an adaptation of superheating, but the time has come for a consideration of designs prepared especially for superheating. This may or may not result in a reduction of boiler pressures, but the possibility of reducing pressures becomes important in the application of superheaters to old locomotives, the boilers of which are weakened by age and unequal to the task of maintaining high pressures. For example—by equipping an old locomotive, originally over-cylindered, with a superheater, the boiler pressure may be reduced to a reasonable extent without sacrificing power, thus adding some years to the effective life of locomotives, provided the cylinders and running gear are in condition to warrant the expenditure. This phase of superheating has not received the attention which its important merit deserves.

The attention of the writer was recently called to an operating advantage offered by the superheater which, perhaps, has not been fully appreciated. In the case referred to it is found possible for the superheater locomotive on a long passnger run to pass one of the customary coaling and watering stations without stopping. On this particular road the single application of superheating makes it exceedingly popular with operating and mechanical officials. If trains hauled by superheater locomotives are not increased in weight it may become possible to effect a material saving in certain localities from the economy thereby obtained.

Whether or not present types of superheaters prevail is not important in the present discussion. It is important for the principle of superheating to receive attention particularly from those who are now facing or are soon to face the necessity of increased capacity of locomotives with increasing weight and other limitations. From the standpoint of capacity the superheater seems to have come opportunely, because while it may be possible to increase the weight of both passenger and freight locomotives, it is desirable to have recourse to some other means for increasing capacity. As the country builds up into larger communities, traffic requirements are sure to increase, and anything which tends toward an increase of locomotive capacity should be earnestly welcomed. From the standpoint of augmented capacity, superheating is of great interest to American railroad men at the present time.

The first successful superheater applied on this continent was in 1899. At the present time 205 locomotives are equipped, or being equipped, with this device. That superheating has made such progress in so short a time is, of itself, remarkable, and it is fair to expect its satisfactory development from present experience.

Electricity on Steam Railroads.

Committee.—C. A Seley, Chairman; W. R. M'Keen, Jr., L. R. Pomeroy, C. F. Street, F. J. Cole.

The instructions of your Committee on Electricity on Steam Railroads read as follows: The committee to consider and present to the Association the relative advantages of the different systems of electric traction now in use as applied to interurban and suburban lines; also, as far as possible the relative cost of operating such lines by electricity and steam. The committee are also instructed to include in its investigations the different systems of gasoline, gasoline-electric and steam motor cars.

It is perfectly apparent that the density of traffic is the ruling factor as to whether the steam or the electric road will prove the more profitable.

It is quite well known on old established lines what the passenger returns will be with fairly steady business conditions, provided there is no change in the train accommodations, but if there is an increase in train service it is almost sure to build up an induced traffic, the amount of which is difficult to estimate. Unless, therefore, there is a reasonable basis of expectation for such traffic, the steam railway that can fully care for its own is not in need of a new system, and the expediency is doubtful.

It is believed, therefore, that where there is a sufficient density of traffic it will pay steam railroads to handle their local suburban and interurban travel electrically, giving frequent trains and frequent stops, equaling the convenience and accessibility of trolley lines, for which the public does not have to stop to consult time tables, buy tickets and go to inconvenient points to get on trains. Traffic of this kind should have its separate tracks, as it would get in the way of fast through trains and itself would be impeded by slow freight trains using the same tracks.

It would be possible to make a combination service in some territories, running slow freight though at certain hours when travel was light, or if the character of the freight would permit, to have special separate freight units which could keep out of the way of passenger traffic. As before stated, the particular class of service and the system to be used must be chosen with special reference to the situation, and these vary so that no general rule or information will apply.

It is our belief, however, that few situations will figure out profitably with the combination service, and that if electrification is warranted for passenger traffic, that a complete change will be desirable, except possibly where there is through travel involved also.

Relative Advantages of Different Systems of Electric Traction Now in Use.

By far the greater portion of present car equipments are for the use of direct current, but of late alternating current has entered the field and there are some very interesting single-phase operations, the motors employed being capable of running on either direct or alternating current, and by having suitable transformers on the cars, high line voltage may be carried, thus reducing the cost of distribution.

Long distance distribution is best accomplished by alternating current of high voltage, and if direct-current motor equipments are used the current is transformed at substations at suitable intervals and generally not over ten miles apart. These stations are equipped with transformers for stepping down the voltage, and with rotary convertors for changing the current to direct at suitable voltage for the line.

Substations on lines employing single-phase machinery have only the transformers, no rotaries being required, and this also cuts off cost of attendance except occasional inspection.

The single-phase operation is economical on account of high voltage used on the line and cheapens very much the cost of distribution from the substations, there being no difference between the power station and substations. The car equipments, however, are more expensive than direct-current apparatus, so that, assuming both to be of equal efficiency, the number of equipments and apparatus required must be considered, and their extra cost weighed as against the low cost of direct-current machinery and more expensive distribution to the line.

Gasoline, Gasoline-Electric and Steam Motor Cars.

Some time prior to the development of electric interurban railways the steam motor car or dummy, in many cases hauling a trailer, was used to a moderate extent, but at the present time few of these remain. In response to a demand from railroad managers for a motor car to operate on branch lines and special situations there has been recently a development of motor cars employing gasoline in an internal combustion engine, this engine either directly driving the car or driving a dynamo to generate current to be used for driving motors in the trucks. Some builders interpose batteries between generator and motors to store the current when it is not all needed for propulsion, and to assist in starting on grades when the generator capacity may be insufficient. There is very great flexibility and convenience in this combination, but it is attained at very considerable expense and complication, and requires unusually skilled attendance not commonly available in railroad service.

The examples of the gasoline engine, electric generator, battery and motor types are the cars of the St. Joseph Valley Traction Company's line, built by F. M. Hicks, and the Strang car (American Engineer, March, 1906, page 103), that lately made a sueful run from New York to Kansas City. The gasoline engine on these types is set to run at a constant speed, and this characteristic is essential for the best economy of the internal combustion engine. The size of the engine used may be proportioned to the average power required for normal operation, and the speed variation and excess of power above normal requirements may be supplied by the battery equipment, which also comes into play for lighting and short movements and would also be available to bring the car in in case of a breakdown of the engine or generator.

The gasoline-electric type not employing batteries is illustrated by the D. & H. car. (American Engineer, March, 1906, page 88) recently built by the General Electric Company. The generator on this type of car has to be equal to the maximum requirements, in order to vary the current for the conditions to be met, the field excitation is handled by a separate exciter, chain-driven from the main generator. The controller is semi-automatic and can be set for any predetermined maximum acceleration, and the speed of the car is governed by varying the field strength of the generator. The speed of the engine remains constant after acceleration. This application is very ingenious and effective, and we understand that the car has been put into regular service between Schenectady and Saratoga.

The Union Pacific motor car (American Engineer, May, 1906, page 187) representing the direct mechanical drive application of gasoline power, is driven by a six-cylinder reversible gasoline engine, with crank shaft at right angles to the length of car; a sprocket mounted on same, driving a special chain, transmits the power direct to the driving axle through a second sprocket attached to the axle. The chain easily shows a transmission of power with an efficiency of ninety-seven per cent., which clearly demonstrates that this method of transmission is very close to the maximum efficiency possible.

For the initial start of car, or putting it in motion, a reducing gear is used, and, until the car attains a speed of six or seven miles per hour the economy of this transmission is somewhat reduced; but, as the use of the gear is only temporary and lasts only a few seconds, it can almost be left out of consideration.

The roof of the Union Pacific motor cars is 24 inches lower than the standard height of coach roof. The car being built of steel, with pointed end and smooth exterior surface, the wind resistance is materially reduced, enabling 100 horse-power gasoline engine to drive car at the rate of sixty-five to seventy miles an hour.

The car framing is a combination of steel shapes and braces, the whole tied together by steel plates, making a unit structure, each part supporting the adjacent ones and bearing its proportion of the burden imposed upon it. These cars weigh, motor and all, twenty-six tons, which of course is a very material factor in the high speed attained by cars in service, and affords considerable economy in comparison with the heavier steam motor cars, some of which weigh seventy-five tons and over, with the same seating capacity. Motor car No 7 has seating capacity for seventy-five people, and has, in actual service, carried ninety-five.

One of the most important features in the development of the steel motor car is the reduction in height of car and consequent reduction in weight and decreased wind resistance, a result of which is the system of ventilation—taking fresh air from the front of car, delivering it at floor level and by suction, drawing the foul air out of the roof.

Motor car No. 7 is equipped with metal round sash windows—a window impervious to cold air, dust or water; in fact, is tight as a port-hole on an ocean-going vessel. These windows have demonstrated themselves to be a great luxury to the traveler,

The enclosed inside steps, with side door entrance, have also proven very popular with the traveling public. This side door entrance is permissible with steel car constrtuction without weakening same, the side sill being depressed and divided, a portion being carried over the door and the other portion under, all being tied rigidly in combination with the plate and steel sheathing of the car; forming a structure of such strength as to eliminate the usual weakness caused by a side aperture the size of door-opening in these cars.

The first cars—55 feet in length, seating capacity seventy-five and with an engine of 100 horse-power—are particularly adapted for branch line service, where the traffic is insufficient to support a steam service or anything like electric service.

Interest in the steam car is also being revived, as, for example, the Ganz cars imported from Budapest by the Florida East Coast Rys.; also the Erie R. R. and the C. P. R. R. are experimenting with a steam car equipped with a Scotch marine type of boiler, using a superheater and oil fuel. It is believed that some one may undertake to make a so-called flash boiler that will be applicable to this service.

SERVICE AND UTILITY OF MOTOR CARS.

It is recognized that the so-called motor car, one carrying its own motive power plant, whether gasoline, gasoline-electric or steam, occupies a distinct field of usefulness. Many branch lines, now existing, where travel is light, and on new extensions into unsettled country where the business will not return a profit on steam train service, would have to be run at a loss until a sufficient business was induced or built up by the travel facilities afforded. These situations are the distinct field of the motor car, which can be operated for less per car-mile than by regular steam train or electric methods until the volume of business will warrant the regular transportation methods.

The use of motor cars on the Union Pacific in picking up passengers on branch lines and in delivering passengers at connecting points for through trains is exceedingly lucrative. The matter of giving the branch line patrons of any steam road increased service, with more frequent trips per diem, is very much appreciated by the local community, and their good will is beneficial.

On the hypothesis of the same density of traffic, with the same class of service as would be encountered on one of the ordinary branch lines of the territory west of the Missouri River, the cost per mile for local train service, equipment consisting of two cars and a locomotive, would be about 24 cents, including repairs, fuel, oil, labor, cleaning, etc.; this for passenger, as well as baggage, mail and express service.

Electric service equipment, consisting of one car and trailer, figuring that the density of traffic is sufficiently regular to support same seven days in a week, is estimated at about 18 cents a mile.

The gasoline service (mechanical-drive only considered), consisting of one car and trailer, with baggage, mail and express service, would cost 15 cents per mile. The latter, of course, would be independent of whether service was six days or seven days per week, the cost simply depending upon the service rendered.

ENGINE HOUSE RUNNING REPAIR WORK ON LOCOMOTIVES.

Committee—H. T. Bentley, chairman; P. Maher, F. T. Hyndman.

The subject assigned your committee to report on is rather indefinite in so far as the latter part is concerned, for we are asked, "with what machine tools and hand tools should a roundhouse be equipped to get the best results?" If we had been told the size of the roundhouse, or the number of engines housed in a given time, we would have had something to work on; but as this information is lacking, will base our report on the assumption that it is a fifty-stall house, and that one hundred and fifty engines have to be taken care of in the twenty-four hours.

In the first place, we are asked, "What is the best practice for doing this work (running repairs on locomotives), handling reports, etc., made by foremen, engineers, road foremen and inspectors," and would say that a system as outlined below will give the maximum results with the minimum delay and expense. It is very necessary to know what work has to be done on an engine before it arrives in roundhouse, so that, if for the drop pit, it can be run there without delay, or, if any heavy repair work is necessary, it can be run into a stall convenient to machine shop, which will save time of machinists.

A system of engineers' work reports and engineers educated to report their work fully and intelligently; these slips should be deposited in a box or other receptacle, located centrally, and preferably close to the foreman's office, so that the man in charge of handling them, and distributing the work, can do so and keep in touch with the foreman.

A system of writing out the work on separate slips and giving it to the proper man, who signs same and returns it to the gang foreman when work is done, has many advocates, and enables a close check to be kept on improper repairs. Whichever system is used, it is absolutely necessary to know who has done the work, for future reference.

When an engine arrives in the roundhouse the inspector should at once make an examination of it, reporting all the work found, on the regular engineers' slip, but signing his own name and adding the word "inspector," so that a check can be kept on the engineers to see if they are looking over their engines properly.

If any repairs are necessary the gang foreman should have his men ready to make them, so as to avoid any delay; if for washing out, the steam and water should be blown off into a proper receptacle and hot water used for washing out and filling up. Great care should be exercised so that the machinists are not sent to an engine that is to be washed out, unless they can do their work without interruption. If it is necessary to grind in boiler checks, renew staybolts, or do other work that can only be done when the water is out of the boiler, advantage should be taken of this opportunity.

On some roads the road foreman of engines uses a regular blank for reporting work that he finds while riding on engines. This report should be turned in, so that it can have attention while the engine is out of service, and we recommend that work reported by a road foreman should have particular attention paid to it, as his discipline is hurt to a great extent, and his usefulness impaired, if no notice is taken of his reports.

There are so many different conditions existing in this country that it is a difficult matter to draw a hard and fast line as to how engine-house running repairs should be taken care of. On some roads the water conditions are good, so that boiler work is almost unknown. On others the amount of boiler work fixes the time an engine is out of service. On some roads, with poor coal, it is not unusual to change grates nearly every trip, while on others the coal is of such good quality that grate troubles are almost unknown. However, in all cases, the prime object of a roundhouse organization is to quickly take care of the neecssary repairs, and to do so the force must be so built up that when an engine arrives in the house all concerned must know what to do and how to do it, having such tools at their command that experience teaches are most necessary.

The location of a roundhouse of the size being considered has to be taken into account. If in close proximity to the main shop, less machine tools may be necessary, but where entirely self-supporting, a proper outfit should be supplied to take care of anything that may come along.

In addition to the small tools owned and carried by the various mechanics, we recommend the following: 48 by 48 in. by 8-ft. planer, 24-in. lathe, 40-in. heavy drill press, 20-in. drill press, emery wheel, 16-in. bolt lathe, 22-in. shaper, bolt-cutter to take up to 2 ins., 36-in boring mill, hydraulic or screw plates for driving box brasses, rod bushings, etc.

Suitable cranes around engines and drop pits, either supported by posts or roof, so as to take care of air pumps, steam chests, front end doors, driving boxes and other heavy parts. The lifting on and off of cabs is something that should not be overlooked.

A driving-wheel drop pit capable of taking care of at least two engines at a time, an engine-truck drop pit capable of taking care of at least two engines at a time, a tender-truck drop pit, if trucks are suitable for wheels to be dropped.

Two gasoline or oil tire heaters, with proper-sized hoops and burners, can be used for straightening frames, etc.; a rotary valve-seat planer of sufficient size to take the largest-sized seats, a boring bar for piston valve bushings; a cylinder boring bar; 4 piston rod pullers, various sizes; 12 differential chain hoists; 4 ½-in. grab chains; 4 ⅝-in. grab chains; 12 pinch bars; 12 heavy capacity jacks, 35 or 40-ton, hydraulic or lever; 12 screw jacks for holding up work; 4 lever journal jacks; 2 lever jacks for pilot and tank work.

Two air hammers made out of pipe or old hydraulic jacks for driving out rod and frame bolts; 6 air motors, various sizes, two to be end motors for close work; 4 crosshead lifters; 2 spring pullers; 3 close chisel bars; 6 long chisel bars.

Four two-wheel trucks for moving material; 1 blacksmith forge; 1 set ratchets and rollers for valve setting; 2 four-wheel rod trucks; 1 portable arrangement for hydrostatic test.

Steam-gauge tester; complete set of drills, ¼-in. to 2-in.; small breast drill; complete set standard reamers, ¾-in. to 2-in.; pipe vise; complete set of standard taps, ¼-in. to 2-in.; cold chisels, as many as necessary.

One complete set of pipe cutters, dies and taps from ¼-in. to 3-in.; sufficient adjustable pipe wrenches to accommodate the force of men that the work requires; 6 each, open wrenches, ⅜ by ⅝ in., to 1¼ by 1¼ ins.; 2 each, large size open wrenches, up to largest size nut on locomotives; 6 mauls, various weights, 8 to 16 lbs; 12 handle punches, ¾ to 1¼ ins.; 2 pneumatic hammers for boilermakers, chipping, etc, caulking tools, etc.; 1 complete set staybolt reamers and taps; in fact, complete outfit for staybolt, flue and grate work.

The above are about the most important factors in roundhouse work, but we would advocate sufficient chisels, gauges, hack saws, files, scrapers, straight edges, etc., to accommodate the force maintained at each roundhouse in order that one man may not be held up on a job waiting for another man to get through with some small tool.

Each roundhouse should have a separate tool room of its own, with a man in charge, both day and night, to handle the tools on a check system; otherwise, it will be impossible to maintain roundhouse tools.

In addition to above on engine-house running repairs on locomotives, the following good suggestions were brought out in discussion of this paper at the Western Railway Club meeting, held at the Auditorium Hotel, Chicago, Tuesday evening, March 20, 1906, and are endorsed by your committee.

The use of a floating or hospital gang in the roundhouse, to which gang will be turned over the heavier jobs, so as to get engines into service quickly, instead of having the work drag along with various men being put on and taken off according to the exigencies of the service; this service will often enable an engine to be kept out of the back shop and increase the mileage between shoppings.

A long master wedge for drawing piston rods into crossheads before the regular wedge is applied.

A small bolt lathe mounted on a truck and run by electric or air motor, for use around an engine where new rod, truck or cylinder bolts are being fitted, to save running back and forth to machine shop.

Always keep one engine on blocks undergoing moderately heavy repairs, so that machinists can be kept busy at all times when work in the roundhouse falls off temporarily. It is claimed that

work done in this manner costs more, but where business fluctuates it is a good proposition.

The neglect of running repairs causes engine failures to increase and also decreases the life of an engine between shoppings.

A hydraulic press operated by a screw, for forcing out rod bolts, etc., saves bolts from being upset when hit by a sledge.

An inverted "Y," with the upright leg slotted, which is used for removing heavy cylinder heads, the method of operating being to stand the "Y" against cylinder head, with feet on floor and stud through slot, the nut being put on and tightened so that when cylinder-head nuts are removed head can be "walked" away and stood ready for application.

FIRE KINDLING.

BY MR. P. MAHER, S. M. P., T., ST. L. & W. RY.

My recommendation would be to carry the subject over another year and place it in the hands of a committee of at least five members representing roads that use anthracite and bituminous coal, also representation from some of the Western roads using fuel oil. When we take into consideration some of the important features that govern a subject of this kind, i. e., the antiquated roundhouse with no facilities, the more modern roundhouse, equipped with hot water system and maximum air and steam pressure for blowing up locomotives, the improved smokejack, the various kinds of fuel, etc., we can readily appreciate the fact that it could be handled more intelligently by a committee than by an individual.

CATALOGS.

IN WRITING FOR THESE CATALOGS PLEASE MENTION THIS PAPER.

PIPE UNIONS.—Joseph Dixon Crucible Company, Jersey City, N. J., is issuing a pamphlet which contains an article by Mr. W. H. Wakeman, on "Unions for Steam Pipes," which was first published in "Graphite." The subject is considered from an engineering standpoint and contains much matter of interest to steam users. Copies can be obtained upon request.

FRICTION DRAFT GEAR.—The Republic Railway Appliance Company, St. Louis, Mo., is issuing a folder which illustrates the Republic friction draft gear by means of sectional views. A brief description of the operation and a reprint of an editorial from the *Railroad Gazette* on friction draft gears for wooden cars is also included.

EXPANSION BORING TOOL.—The Davis Expansion Boring Tool Company, 202 South Commercial St., St. Louis, is issuing a small catalog descriptive of several different designs of boring tools, both solid and expansion. These tools have a very good record in the matter of reducing the cost of output, and are manufactured in 228 different styles and sizes for all purposes.

PISTON VALVES.—The American Balance Valve Company is issuing a leaflet calling attention to the new design of semi-plug piston valves recently perfected. It states that one railroad has already in service and specified on new power 1,206 of these valves. These valves are so made that they will run over ports without bridges. Booklet No. 22, issued by the company, tells all about them. It can be obtained upon request.

MACHINE MOULDING.—Ph. Bonvillain & E. Rongeray, Paris-Aubervilliers, France, are issuing a pamphlet on the "Universal System of Machine Moulding." It contains a large amount of very interesting and instructive matter on the latest methods of moulding. It shows that machine moulding can be economically carried to a much broader field than is now generally considered possible. It is thoroughly illustrated, printed in English and can be obtained upon request.

LOCOMOTIVE COALING STATION.—The Gravity Measuring Coal Chute Company, 907 Mutual Building, Richmond, Va., is issuing a catalog which is profusely illustrated with views and line drawings showing the construction and operation of its new design of gravity measuring coal chutes, which accurately measure the amount of coal taken by a locomotive by means of an auxiliary pocket without the use of scales or rehandling. This type of chute is now in successful use on several railroads, and is clearly described in this catalog, which can be obtained upon request.

ELECTRIC AND PNEUMATIC DRILLS.—The Chicago Pneumatic Drill Company, Fisher Building, Chicago, is issuing special circular No. 56, which illustrates and briefly describes several different types of the air cooled Duntley electric drills for machine and car shop usage. It also shows standard types of the "Little Giant" drills, and improved "Little Giant" drills which are fitted with Corliss valves. These are claimed to be the most powerful drills ever devised for their weight. Several specialities are also shown, including a magnetic-holder-on, portable blower, portable drilling stand, etc.

GRAVITY DUMP CARS.—E. W. Summers, Farmer's Bank Building, Pittsburgh, is issuing a small folder which shows the construction and operation of the Summers gravity dump car in a clear manner. This car has a number of special and interesting features, and is arranged to discharge its load by gravity on either side, both sides, or in the center of the track, the construction being such that the discharge is controlled by cranks at the end of the car. These cranks are so connected to the doors that when they are released the door is automatically locked at that point. The folder shows cross sections of the car in operation under different service conditions. Copies can be obtained upon request.

CAR WHEEL LATHES.—Progress Reporter No. 31, published by the Niles-Bement-Pond Company, illustrates and describes special machines for turning steel tired car wheels. This issue supersedes No. 4, published in September, 1904, on the same subject, which during the past two years has seen so large an improvement as to make the former methods recommended out of date. The present issue shows a large number of illustrations of machines and appliances for handling and turning the wheels, and includes much valuable information in connection with the work. Dimension drawings of proper tools for turning car wheels are included.

VARIABLE SPEED MOTORS.—The Northern Electrical Manufacturing Company, Madison, Wis., is issuing a catalog describing the Northern single voltage variable speed motors. Complete descriptive matter of the motor and its operation, as well as a large number of illustrations, showing its application to many different types of machine tools are included. In brief the system used obtains speed variation by the insertion of resistance in a shunt field. The special design adopted allows variations of 200 to 300 per cent. in speed with economical operation at all points. These motors use but one commutator and are of very simple and light construction. The catalog also considers the proper controlling apparatus for different drives.

BLUE PRINT MACHINE.—The Revolute Machine Company, 523 West 45th St., New York, has recently perfected a blue print machine of special merit. This machine consists of a rotating glass cylinder, which lies in a series of narrow belts, and within this cylinder are placed two mercury vapor electric lamps. The roll of paper to be printed is placed in a box on top of the machine, and feeds in continuously between the belts and the cylinder. The tracings are inserted between the paper and the cylinder, and after passing around ¾ of the circumference of the cylinder are deposited with the paper in a box in the front part of the machine. Very high speed is claimed for this apparatus as well as especially sharp, clear prints. Its features are clearly shown in a small folder, which can be obtained upon request.

LOCOMOTIVE VALVE GEAR.—The Locomotive Appliance Company, Old Colony Building, Chicago, is issuing an attractive catalog descriptive of its latest design of valve gear for locomotives. This gear is clearly shown by line drawings and photographic reproductions of the different parts and its operation is clearly explained in the type matter and illustrated by the reproduction of actual indicator cards. This latest design of Alfree-Hubbell valve gear is all contained within the cylinder casting, the valve stem connecting to the regular rocker arm of the locomotive without the use of gears or other attachments outside the steam chest. It has been in service on several roads for some time with much success. A substantial increase in the tonnage of the locomotive equipped with this valve gear, it is claimed, has been attained in all instances. Copies of the catalog can be obtained upon request.

ELECTRIC APPARATUS.—The General Electric Company is issuing a very attractive catalog, describing and illustrating different types of electric radiators. These in many cases are portable and illustrations are given, showing their application for resident and office use. They are made in luminous and non-luminous types. The same company is issuing a number of bulletins, one of which illustrates and describes a 25 k.w. Curtis steam turbine generator set. It is designed to take the place of small direct or belt connected engine driven sets. Another illustrates and describes panels for two and three-phase alternating induction motors, being designed for individual installation and not intended to form part of the main switchboard. The third bullettin describes, by means of illustrations, curves and complete written matter the type

GEA 605A railway motors. This is a single-phase motor rated at 75 h.-p., and is specially recommended for interurban work.

ELECTRIC MOTORS AND TRANSFORMERS.—The Crocker-Wheeler Company, Ampere, N. J., has issued bulletins Nos. 64 and 65, the former of which thoroughly illustrates and carefully describes form I. electric motors, which are made in sizes of 3 to 45 h.-p. Also similar generators in sizes from 2½ to 40 k.w. A number of illustrations showing these motors applied to different machine tools and a description of the application are included. Bulletin No. 65 illustrates and describes in detail core type transformers for high tension power work. These transformers have received a large amount of favorable mention by their users. The same company is also issuing a pamphlet on its system of electric motor control which uses a three-unit balancer and obtains six different voltages. Diagrams of the different controller connections for different speeds of motors are given. This system of motor control is in successful operation in many large plants.

ELECTRIC MOTOR AND TRAILER TRUCKS.—A pamphlet describing electric motor and trailer trucks has just been issued by the American Locomotive Company illustrating the types of this equipment, designed and built by them. The pamphlet begins with a description of the principles of the designs, of which fifteen are illustrated by full-page drawings. The designs illustrated include motor trucks for the New York Central suburban service, for the Paris-Orleans, the Schenectady, the Delaware & Hudson, the Brooklyn Rapid Transit, the Buffalo & Lockport and other railways. The drawings show the construction in detail, rendering it an easy matter to study the designs. In addition to the drawings, nearly all of the trucks are illustrated by reproductions from photographs. Among the details illustrated are cast steel and wrought iron bolsters, truck hangers, spring planks, Brinkerhoff-Doyle wheel hubs and journal boxes with collarless and collar axles. Copies of the pamphlet will be supplied upon request to the American Locomotive Company.

PNEUMATIC APPARATUS.—The Ingersoll-Rand Company, 11 Broadway, New York, is issuing several new catalogs and bulletins, describing pneumatic tools, air compressors, rock drills, etc. One of these is given up completely to the description of the Imperial piston drills, which are shown in several different forms and sizes. A number of illustrations showing these drills in operation under railroad shop conditions are included, and a list and table of parts for each type are also given. Another catalog thoroughly describes and illustrates the Imperial power driven air compressor. This machine is shown in several different forms and sizes, driven by belt, chain or gear, in single and duplex acting designs. Much matter of interest to compressed air users will be found in this catalog. A third catalog considers rock drills and mountings. Complete illustrations and descriptive matter of pneumatic rock drills and appliances are given therein. A small booklet entitled "Pneumatic Tools" briefly considers a few of the more important designs of Imperial riveting and chipping hammers, Haeseler Imperial drills, yoke riveters, rivet forges, etc.

BLOWERS, FANS AND ENGINES.—The American Blower Company, Detroit, is issuing several new catalogs and leaflets descriptive of different blowing apparatus; one of these deals exclusively with disc ventilating fans, and describes, by means of illustrations and type matter, several different designs of these fans. The important details are given careful attention. Another catalog deals exclusively with steel plate fans, which are treated in a similar manner. Illustrations of parts and details being included. A third catalog deals with the blower complete as used for heating, ventilating and drying. These are shown either as direct-driven or belted from shaft or engine. Several interesting applications of direct-connected electric motors are included. Another catalog shows many of the interesting and important details of the enclosed high-speed, self-oiling blowing engines furnished by this company. A small booklet is also being sent out which briefly illustrates and describes several different designs of heating coils for dry kilns. Any of these catalogs can be obtained upon request.

LOCOMOTIVE TESTS—PENNSYLVANIA RAILROAD.—A compilation by Dr. W. F. M. Goss from the recent publication by the Pennsylvania Railroad, describing the locomotive tests and exhibits of that road at the Louisiana Purchase Exhibition, has been issued by the American Locomotive Company. This pamphlet presents, in concise form, an account of the locomotive tests at St. Louis, giving specific information concerning each of the locomotives tested, and presenting the results separately for each of the eight locomotives. In the pamphlet four pages are devoted to a description of each locomotive and a discussion of its performance, including a summary of the data of the tests. This is followed by comparisons and conclusions compiled by Dr. Goss from the very elaborate record of the tests recently issued in book form by the Pennsylvania Railroad. While the pamphlet does not add to the information given in the book, it presents the conclusions and comparisons in form for convenient reference. This pamphlet will give a very wide distribution to a summary of the important records of the testing plant at St. Louis. For a more complete record the book published by the Pennsylvania Railroad may be consulted, than which there is nothing more valuable in recent literature of the locomotive. Copies of the pamphlet may be had from the American Locomotive Company.

NOTES.

THE QUINCY, MANCHESTER, SARGENT COMPANY.—This company announces that Mr. James L. Pilling is no longer in any way connected with it.

STURTEVANT HEATERS.—The new locomotive shops of the Missouri, Kansas & Texas R. R., Parsons, Kansas, are being equipped with a complete heating and ventilating system, installed by the B. F. Sturtevant Co.

BUDA FOUNDRY BRANCH IN ST. LOUIS.—The Buda Foundry & Manufacturing Company of Chicago has opened a branch house in the Frisco Building, and also established a warehouse in St. Louis. The new branch will be in charge of Mr. W. E. Marvel.

DAYTON PNEUMATIC TOOL CO.—David O. Holbrook, who until recently was Vice-President of the Pennsylvania Malleable Company and the Central Car Wheel Company, has been elected Vice-President of the Dayton Pneumatic Tool Company, Pittsburg, Pa., and has opened an office for the Company at No. 717 Park Building, Pittsburg, Pa.

CROCKER-WHEELER CO.—Dr. Schuyler Skaats Wheeler, president of the Crocker-Wheeler Company, Ampere, N. J., sailed June 14, on the Lloyd steamship "Barbarossa," for a short European trip. He was accompanied by Prof. Francis B. Crocker, Professor of Electrical Engineering at Columbia University, who has been associated with him in business for many years

GENERAL ELECTRIC OFFICE AT SAN FRANCISCO.—The General Electric Company which established its main office in the Union Savings Bank Building at Oakland, California, immediately after the San Francisco disaster, as well as a local office at No. 1759 Geary Street, in the burned city, has leased a suite of rooms in the new Monadnock Building, which they expect to occupy about June 15, 1907. For handling the present business, a half a block of land has been leased in Emeryville, and a temporary building is now about completed for taking care of stock, and work has already been started on a new warehouse, which will be located at the south end of the block, bounded by Kansas, Rhode Island, 15th and Alameda Streets.

NORTON COMPANY.—The Norton Emery Wheel Company, Worcester, Mass., has just been granted permission by the state legislature to change its name to Norton Company. For a considerable period this company has been making its grinding wheels of alundum, an artificial abrasive, in place of emery. The Norton Company has a plant at Niagara Falls, N. Y., which manufactures alundum exclusively for the use of the Worcester works, and during the past year it has been found necessary to double its size. The process of making alundum consists in taking the purest amorphous oxide of aluminum found in nature, known as the mineral bauxite, purifying it and melting it in an electric furnace in a large, homogeneous uniform bath. Upon cooling, this molten fluid solidifies and crystallizes in solid masses of alundum of great purity and absolute uniformity throughout, and of a hardness greater than any known substance except the diamond. The process is patented both at home and abroad, and was awarded the grand prize at the Louisiana Purchase Exposition.

THE ARMSTRONG MFG. COMPANY.—This company of Bridgeport, Conn., has opened a branch office and warerooms at 23 South Canal Street, Chicago, Ill. The new branch is in charge of Mr. Hugh S. Laing, formerly assistant manager of the New York City branch. A full stock will be maintained in the warerooms to enable customers in the district to receive their orders promptly.

VENTILATING THE GALLITZIN TUNNEL.—After the completion of the Gallitzin Tunnel on the Pennsylvania Railroad it was found that great difficulty was experienced on account of the smoke and gases discharged by locomotives. These caused the atmosphere to become so bad as to seriously interfere with the work of the trainmen, and it was necessary to provide relief. This was done by constructing at the east end a ventilating apparatus, consisting of a sheet iron hood about 50 ft. long, enclosing one track and having an inner surface coincident with the soffit of the tunnel arch and walls. The outer surface converged from the outer end of the hood to the portal of the tunnel so as to give it a wedge-shaped cross-section. A Sturtevant blower was installed at the end of the hood on each side and delivered air through it to the tunnel portal, where a narrow opening in the inner surface of the hood permitted the blast to be forced into the tunnel nearly parallel with its axis. Trains pass through this tunnel in one direction only, and as the grade is up from this end they are usually drawn by two locomotives in front and one pusher behind. As soon as the forward locomotive enters the tunnel the fan is started. The large volume of air which is forced into the narrow space between the train and the tunnel lining drives the smoke and gas in advance of the locomotive, so that its engineer can keep the cab windows open and is supplied with an abundance of fresh pure air. The second locomotive does not work in the tunnel, and the smoke from the pusher never reaches the front of the train. This arrangement is considered efficient and satisfactory.

CONVENTION EXHIBITS.

The exhibits except for the large Niles-Bement-Pond driving wheel lathe and the track exhibits were on the Steel Pier. There were 244 exhibitors with a total floor space of 65,235 sq. ft., as against 208 exhibitors with a floor space of 38,123 sq. ft. at Manhattan Beach last year. Among the exhibitors were the following:

Acme Ball Bearing Company, Chappaqua, N. Y.
Adams & Westlake Company, Chicago, Ill.
Adreon & Company, St. Louis, Mo.
Ajax Metal Company, The, Phila., Pa.
American Balance Valve Company, Jersey Shore, Pa.
American Brake Shoe & Foundry Company, Mahwah, N. J.
American Car & Foundry Company, New York.
American File & Sharpener Company, New York.
American Lock Nut Company, Boston, Mass.
American Locomotive Company, New York.
American Mason Safety Tread Company, Boston, Mass.
American Palace Car Company, New York.
American Steam Gauge & Valve Mfg. Company, Boston, Mass.
American Steel Foundries Company, Chicago, Ill.
American Water Softener Company, Phila., Pa.
Armstrong Bros. Tool Company, Chicago, Ill.
Asbestos Slate & Sheathing Company, Ambler, Pa.
Ashton Valve Company, Boston, Mass.
Baeder, Adamson & Company, Phila., Pa.
Baker Heating & Supply Company, New York.
Baldwin Locomotive Works, Phila., Pa.
Baldwin Steel Company, New York.
Barnett Equipment Company, Newark, N. J.
Besley, Chas. H. & Company, Chicago, Ill.
Bettendorf Axle Company, Davenport, Ia.
Bliss Electric Car Lighting Company, Milwaukee, Wis.
Boker & Company, Herman, New York.
Bordo, L. J., Company, Phila., Pa.
Bowser, S. F., & Company, Fort Wayne, Ind.
Bradford Draft Gear Company, Chicago, Ill.
Brady Brass Company, Jersey City, N. J.
Brown Hoisting Machine Company, Cleveland, O.
Buckeye Steel Castings Company, Columbus, O.
Buffalo Brake Beam Company, Buffalo, N. Y.
Butler Draw-bar Attachment Company, Cleveland, O.
Camel Company, Chicago, Ill.
Carey, Phillip Mfg. Company, Lockland, Cincinnati, O.
Chicago Car Heating Company, Chicago, Ill.
Chicago Pneumatic Tool Company, Chicago, Ill.
Cleveland Car Specialty Company, Cleveland, O.
Cleveland Pneumatic Tool Company, Cleveland, O.
Columbus Pneumatic Tool Company, Columbus, O.
Consolidated Car Heating Company, Albany, N. Y.
Consolidated Railway Electric Lighting & Equipment Company, New York.
Crocker-Wheeler Company, Ampere, N. J.
Crosby Steam Gage & Valve Mfg. Company, Boston, Mass.
Davis, John, Company, Chicago, Ill.
Davis Expansion Boring Tool Company, St. Louis, Mo.
Davis Pressed Steel Company, Wilmington, Del.
Dearborn Drug & Chemical Works, Chicago, Ill.
Dearborn Paint Company, Chicago, Ill.
Detroit Lubricator Company, Detroit, Mich.
Diamond Machine Company, Providence, R. I.
Dickinson, Paul, Chicago, Ill.
Dill, T. C., Machine Company, Phila., Pa.
Dixon Crucible Company, Joseph, Jersey City, N. J.
Drouve Company, The G., Bridgeport, Conn.
Duff Manufacturing Company, Pittsburgh, Pa.
Duner Company, Chicago, Ill.
Edwards Company, The O. M., Syracuse, N. Y.
Electric Storage Battery Company, Phila., Pa.
Fairbanks, Morse & Company, Chicago, Ill.
Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio.
Farlow Draft Gear Company, Baltimore, Md.
Flannery Bolt Company, Pittsburgh, Pa.
Franklin Railway Supply Company, Franklin, Pa.
Frost Railway Supply Company, Detroit, Mich.
Galena-Signal Oil Company, Franklin, Pa.
Garlock Packing Company, Palmyra, Pa.
General Electric Company, Schenectady, N. Y.
Gold Car Heating & Lighting Company, New York.
Gould Coupler Company, New York.
Gould Storage Battery Company, New York.
Green, Tweed & Company, New York.
Hale & Kilburn Manufacturing Company, Phila., Pa.
Hammet, H. G., Troy, N. Y.
Hanlon Locomotive Sander Company, Winchester, Mass.
Harrison Dust Guard Company, Toledo, O.
Heath & Milligan Mfg. Company, Chicago, Ill.
Holcomb Steel Company, Syracuse, N. Y.
Homestead Valve Mfg. Company, Pittsburgh, Pa.
Hunt-Spiller Mfg. Corporation, Boston, Mass.
Independent Pneumatic Tool Company, Chicago, Ill.
Ingersoll-Rand Company, New York.
International Correspondence Schools, Scranton, Pa.
Invincible Roll Screen Company, Brooklyn, N. Y.
Jenkins Brothers, New York.
Justice Company, Phillip S., Phila., Pa.
Kalamazoo Railway Supply Company, Kalamazoo, Mich.
Kennicott Water Softener Company, Chicago.
Landis Machine Company, Waynesboro, Pa.
Landis Tool Company, Waynesboro, Pa.
Latrobe Steel & Coupler Company, Chicago, Ill.
Lincoln Electric Mfg. Co., Cleveland, O.
Lord Company, G. W., Phila., Pa.
McConway & Torley Company, Pittsburgh, Pa.
McCord & Company, Chicago.
McGuire-Cummings Mfg. Company, Chicago, Ill.
Manning, Maxwell & Moore, New York.
Merritt & Company, Phila., Pa.
Michigan Lubricator Company, Detroit, Mich.
Moran Flexible Joint Company, Louisville, Ky.
Morse Twist Drill & Machine Company, New Bedford, Mass.
Nathan Mfg. Company, New York.
National Car Coupler Company, Chicago, Ill.
National Malleable Castings Company, Cleveland, O.
New Jersey Tube Company, Newark, N. J.
New York Air Brake Company, New York.
Niles-Bement-Pond Company, New York.
Norton Emery Wheel Company, Worcester, Mass.
Norton Grinding Machine Company, Worcester, Mass.
Oliver Machinery Company, Grand Rapids, Mich.
Penn Steel Casting & Machine Company, Chester, Pa.
Pennsylvania Rubber Company, Jeanette, Pa.
Pittsburg Steel Company, Pittsburgh, Pa.
Pressed Steel Car Company, New York.
Quincy, Manchester, Sargent Company, Chicago, Ill.
Ralston Steel Car Company, Columbus, O.
Republic Railway Appliance Company, St. Louis, Mo.
Riverside Metal Company, Riverside, N. J.
Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N. Y.
Ryerson & Son, Jos. T., Chicago, Ill.
Safety Car Heating & Lighting Company, New York.
Schoen Steel Wheel Company, Pittsburgh, Pa.
Sellers & Company, William, Phila., Pa.
Shelby Steel Tube Company, Pittsburgh, Pa.
Sight-Feed Oil Pump Company, Milwaukee, Wis.
Sprague Electric Company, New York.
Standard Coupler Company, New York.
Standard Steel Works, Phila., Pa.
Star Brass Mfg. Company, Boston, Mass.
Stoever Foundry & Mfg. Company, Myerstown, Pa.
Symington, The T. H., Company, Baltimore, Md.
Talmage Mfg. Company, Cleveland, O.
Thompson, C. A., St. Louis, Mo.
Tyler Tube & Pipe Company, New York.
United States Lighting & Heating Company, New York.
United States Metal & Mfg. Company, New York.
Vacuum Cleaner Company, New York.
Wellman & Street, Pittsburgh, Pa.
Western Railway Equipment Company, St. Louis, Mo.
Westinghouse Air Brake Company, Pittsburgh, Pa.
Whitney Mfg. Company, Hartford, Conn.

WANTED.—Foreman for die sinking and drop forge work, experienced in both lines. Give age, references, etc. Address AUTOMOBILE, care AMERICAN ENGINEER AND RAILROAD JOURNAL, 140 Nassau Street, New York.